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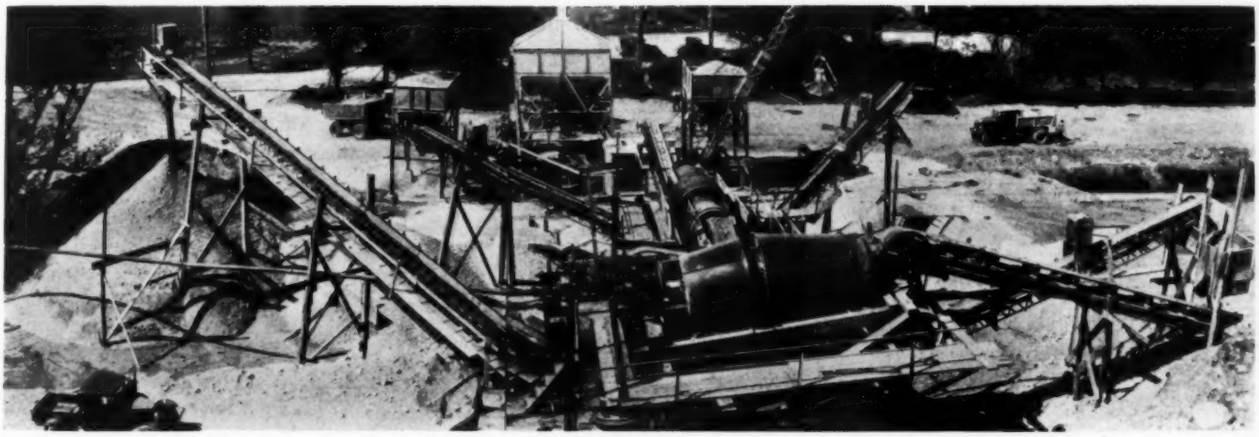

Fig. 1—"Straight-Line" Loading Used in Loading the Trucks with Three Sizes of Coarse Aggregate, Sand, and Bulk Cement Eliminated Turning or Backing Trucks Under the Bins and Thus Eliminated Truck Delays.

PERFORMANCE OF KEY EQUIPMENT USED IN HIGHWAY CONSTRUCTION

By T. C. THEE

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Concrete Pavers, Power Shovels, Elevating Graders and Asphaltic Concrete Mixers are treated in a series of studies of performance reported by Mr. T. C. Thee of the U. S. Bureau of Public Roads. The first of this series—that relating to concrete pavers—is printed herewith. The other studies will be presented in the September and October issues of ROADS AND STREETS.

IN the construction of our highways all contractors, engineers, and equipment manufacturers know that the actual production of any outfit is always far below the potential productive capacity of the key equipment whether it is an elevating grader, paver, power shovel or bituminous mixer.

The key equipment is the pacemaker on every highway construction job and sets a maximum limit on production as established either by the job specification or the mechanical limitation of the mixer. Therefore, the problem of securing as close to the potential productive capacity of the key equipment as possible becomes a problem of determining the factors which are reducing the output of the key equipment and how they may be eliminated.

When the causes of low production are measured by studies of the key equipment and analyzed one generally finds that the delays to the key equipment are due to a lack of balance in the organization as a result of the failure of the contractor to appreciate that the capacity of each of the subordinate organization units must be coordinated and synchronized so as to at least equal the capacity of the key equipment.

The Bureau of Public Roads for some time has been studying key equipment and auxiliary equipment operating under actual field conditions and has made the findings known to those concerned either directly or indirectly in the manufacture of highways.

This article deals primarily with results disclosed from some of the many studies made of key equipment.

The Concrete Paver

Tables I, I-A, I-B, and I-C summarize the results of studies made of 27-E pavers operated in states using the 60-second mixing time. The data in the tables indicate that the pavers operated on a 75.19 second cycle with a 29.57 cu. ft. batch at a rate of 52.44 cu. yd. an hour while operating with no delays, and at a rate of 42.53 cu. yd. an hour while actually operating.

Considering the available working time as the time remaining after time losses due to weather such as rain, wet subgrade, etc., have been subtracted from the total

TABLE I.—SUMMARY OF 27-E PAVER OPERATION AND TIME LOSSES

Total Cubic yards of concrete placed	441,995
Total batches of concrete placed	403,547
Average batch size in cubic feet	29.57
Batches per hour with no delays	47.88
Cu. yds. per hour with no delays	52.44
Batches per hour with minor time losses	38.83
Cu. yds. per hour with minor time losses	42.53

Average Mixer Cycle

	Seconds Per Batch	Seconds Per Cu. Yd.	Per Cent
Raise skip	9.02	8.24	12.00
Mix concrete	64.14	58.56	85.30
Discharge lag	2.03	1.85	2.70
Total cycle	75.19	68.65	100.00

Utilization of the Available Working Time

	Hours	Per Cent
Raise skip	1,011.42	7.91
Mix concrete	7,189.54	56.23
Discharge lag	227.57	1.78
Time paver operated with no delays	8,428.53	65.92
Minor unavoidable delays	438.94	3.43
Minor avoidable delays	1,525.12	11.93
Time paver operated with minor delays	10,392.59	81.28
Major unavoidable delays	1,672.00	13.08
Major avoidable delays	720.34	5.64
*Available Working Time	12,784.93	100.00

*Delays due to weather not included.

study time, the mixers spent 7.91 per cent of this time in raising the mixer skip, 56.23 per cent in mixing concrete, 1.78 per cent in discharging the concrete, or a total of 65.92 per cent of the available working time operating at 100 per cent efficiency, leaving 34.08 per cent lost due to delays and time losses.

Minor delays, which were determined from stopwatch studies of the pavers, caused 15.36 per cent lost time. Major delays, which were delays greater than 15 minutes, caused 18.72 per cent of the delay. The minor and major delays were caused by unavoidable and avoidable losses. The avoidable and unavoidable delays were 17.57 per cent and 16.51 per cent, respectively, indicating that a little over 51 per cent of the delays could have been eliminated by proper managerial foresight and planning.

Fig. 2—Bulk Cement Is Used to a Large Extent in All the Middle Western States

An average of 21.53 per cent of the total study time loss was due to weather. (See Table I-A.) Losses caused directly or indirectly by the weather are the largest losses which occur during the construction of concrete paving. It is very difficult to determine just how the losses should be divided between actual rain and wet subgrade. Very rarely does the production during the first day after a protracted period of idleness proceed at its normal rate. Sometimes the effect is clearly apparent for two or three days.

Weather Bureau Records Should Be Studied.—Some jobs when operating during a very favorable season will lose very little time due to weather while on other jobs the time lost will run over 50 per cent of the total time on the job, all of which indicates the need for the engineer and contractor alike to make a close study of the available Weather Bureau records.

Realizing the fact that losses due to weather effects operations more than just the time lost directly, the percentages computed on the basis of the available working time were used, believing this would make the percentages of the various major and minor time losses more nearly comparable.

Even though the avoidable major time losses for each source of the delay are small, the total avoidable major

TABLE I-A.—CLASSIFICATION OF TIME LOSSES ON P. C. CONCRETE PAVING JOBS

Total Study Time.....16292.18 Hours

Time Lost Due to Weather and Wet Grade, etc.

Character	Unavoidable Delays Hours	Unavoidable Delays Per Cent	Avoidable Delays Hours	Avoidable Delays Per Cent	Total Delays Hours	Total Delays Per Cent
Wet Subgrade	1562.00	9.59	.....	....	.....	....
Rain	1366.05	8.38	.....	....	.....	....
Misc.	579.20	3.56	.....	....	.....	....
Totals	3507.25	21.53	.....	....	3507.25	21.53
Available Working Time					12784.93	78.47

Major Delays Occurring During Available Working Time (Delays of More Than Fifteen Minutes Duration)

Moving Plant, etc	698.20	5.46	18.33	0.14	.....	....
Lack of Materials	227.72	1.78	90.68	0.71	.....	....
Mixer Trouble (Mech.)	188.65	1.48	15.10	0.12	.....	....
Crane Trouble (Mech.)	138.79	1.09	45.55	0.36	.....	....
Water Supply	90.31	0.71	108.38	0.85	.....	....
Lack of Subgrade	33.41	0.26	162.97	1.27	.....	....
Finishing	52.90	0.41	30.93	0.24	.....	....
Miscellaneous	242.02	1.89	248.40	1.94	.....	....
Totals	1672.00	13.08	720.34	5.63	2392.34	18.71
Time Pavers Actually Operated During Available Working Time					10392.59	81.29

Minor Delays Occurring During Time Pavers Actually Operated (Delays of Less Than Fifteen Minutes—From Stopwatch Studies)

Hauling Unit Supply	58.90	0.57	486.06	4.68	.....	....
Hauling Unit Operation	24.71	0.24	133.31	1.28	.....	....
Dumping Trucks	18.30	0.18	170.33	1.64	.....	....
Water Supply	76.36	0.73	188.37	1.81	.....	....
High Subgrade	17.59	0.17	194.57	1.87	.....	....
Mixer Operation	8.53	0.08	99.17	0.95	.....	....
Mixer Mechanical	80.87	0.78	12.51	0.12	.....	....
Joints, Steel, etc	13.60	0.13	71.30	0.69	.....	....
Materials Supply	11.11	0.11	47.64	0.46	.....	....
Finishing Operations	40.15	0.39	23.52	0.23	.....	....
Crane Trouble (Mech.)	4.45	0.04	10.47	0.10	.....	....
Miscellaneous	84.37	0.80	87.87	0.85	.....	....
Totals	438.94	4.22	1525.12	14.68	1964.06	18.90
Time Pavers Operated at 100% Efficiency					8428.53	81.10
Total of All Avoidable Delays (Class B Delays) (Hours)					2245.46	
Possible Operating Time—Class B Delays Eliminated (Hours)					10673.99	
Overall Efficiency of Paver Operation (Per Cent)						78.96

time losses are of sufficient magnitude to warrant elimination. Losses due to major unavoidable delays should be studied because all of them are not strictly "unavoidable" and one should exert as much effort for the reduction of these delays as for the reduction of avoidable major delays.

Minor Delays Can Be Reduced.—The minor delays in Table I-A are expressed as the percentage of the time the paver actually operates. The avoidable minor delays were 14.68 per cent, of which over half were caused by an inadequate supply of trucks, poor truck operation at the mixer or plant, and by the slow dumping of the trucks at the paver. Regardless of whether trucks are hired or owned by the contractor, if an efficient batching plant is laid out, haul roads properly maintained, only those hauling units in good mechanical repair with efficient dumping devices used, and the number of trucks required for the successive hauls advance planned, time losses caused directly or indirectly by the hauling units can be reduced to a minimum.

Minor time losses caused by the water pump breaking down due to the lack of regular mechanical inspection, high subgrade, etc., can all be reduced to a minimum if capable and experienced foremen are employed for each unit of operation.

Table I-B shows that minor delays can be held to a minimum of less than 2 per cent. Poor management on several jobs permitted the minor delays to average almost 40 per cent of the actual operating time. The average time lost on all jobs due to avoidable losses was 17.57 per cent of the available working time. There were four jobs operated with less than 5 per cent time

Fig. 3—Truck Delays at the Mixer Can Be Eliminated Providing an Adequate Truck Supply Is Maintained and if the Truck Drivers Hoist the Load Before a Batch of Material Is Needed

TABLE I-B.—SUMMARY OF TIME LOSSES ON P. C. CONCRETE PAVING

Jobs A—Mixing Time 60 Seconds

Project Number	Per Cent Study Time Lost Due to Weather and Wet Subgrade	Per Cent Available Working Time Lost Due to Major Delays	Per Cent Available Working Time Paver Actually Operated	Per Cent Actual Operating Time Lost Due to Minor Delays	Per Cent Available Working Time Paver Operated With No Time Loss	Per Cent Available Working Time Lost Due to Avoidable Loss	Per Cent Available Working Time Lost Due to Unavoidable Losses	Overall Efficiency In Per Cent
1	50.06	12.25	87.75	19.84	70.34	24.66	6.00	74.04
2	8.72	32.15	67.85	21.04	53.57	22.73	23.68	70.19
3	6.46	4.72	95.28	11.55	84.27	13.82	1.91	85.92
4	21.73	11.60	88.40	14.83	75.27	18.38	6.35	80.37
5	20.95	17.68	82.32	6.00	77.37	20.21	2.42	79.29
6	36.05	8.42	91.58	16.78	76.21	16.21	7.58	82.46
7	3.15	9.53	90.47	25.11	67.75	25.46	6.79	72.69
8	28.16	20.61	79.39	15.45	62.12	17.24	15.63	79.56
9	0.47	12.95	87.05	39.70	52.49	34.13	13.78	60.60
10	27.53	13.76	86.24	21.96	67.29	17.09	13.62	79.75
11	4.73	11.46	88.54	8.53	80.98	4.40	14.62	94.85
12	1.61	7.46	92.54	6.59	86.44	5.93	7.63	93.58
13	26.72	34.22	65.78	23.74	50.16	22.72	27.12	68.83
14	11.67	22.07	77.93	17.88	64.00	27.42	8.58	70.00
15	45.42	12.80	87.20	21.03	68.86	22.27	8.87	75.56
16	21.59	9.88	90.12	17.35	74.49	19.00	6.51	79.67
17	2.01	16.49	83.51	7.55	77.20	5.89	16.91	92.91
18	19.58	8.21	91.79	6.97	85.39	6.56	8.05	92.86
19	49.67	10.65	89.35	6.79	83.28	2.73	13.99	96.83
20	44.60	25.12	74.88	14.72	63.86	12.58	23.56	83.54
21	14.37	21.28	78.72	5.00	74.79	3.64	21.57	95.36
22	29.50	22.50	77.50	19.50	62.40	22.94	14.67	73.12
23	0.00	5.05	94.95	11.82	82.84	7.34	8.76	91.86
24	7.39	10.56	89.44	8.35	81.98	11.31	6.71	87.86
25	13.02	8.08	91.91	1.84	90.22	6.68	3.10	93.10
26	0.40	3.93	96.06	4.90	91.55	3.91	5.64	96.81
27	7.83	30.08	69.92	19.00	56.39	19.80	32.60	83.96
28	6.90	6.82	93.18	17.78	76.61	14.74	8.65	83.86
29	4.55	5.40	94.60	18.23	77.36	15.62	7.02	83.20
30	5.85	11.97	88.03	12.36	79.27	7.21	15.52	91.46
31	20.00	22.25	77.75	11.78	68.60	16.77	14.63	80.35
32	36.25	23.01	76.18	26.34	56.12	18.01	25.87	76.70
33	48.06	21.94	78.06	35.85	50.07	34.35	15.57	59.31
34	13.37	17.28	82.72	28.45	59.19	27.02	13.79	68.66
35	24.82	26.38	73.62	28.94	52.31	26.49	21.20	66.39
36	1.06	25.21	74.79	25.83	55.47	9.90	34.63	84.86
37	18.34	13.65	86.35	39.22	52.48	31.33	16.29	62.69
38	7.13	16.56	83.44	32.59	56.25	18.96	24.79	74.79
39	56.51	16.25	83.75	29.39	59.15	25.87	15.00	69.57
40	5.82	23.65	76.35	10.31	68.48	8.89	22.63	88.51
41	13.21	29.68	70.32	20.70	55.76	17.27	26.97	76.35
Averages	21.53	18.71	81.29	18.90	65.92	17.57	16.51	78.96

TABLE I-C.—SUMMARY OF HOURLY PRODUCTIONS ON P.C. CONCRETE PAVING

Jobs A—Mixing Time 60 Seconds

Project Number	Average Mixer Cycle Seconds	Batch Size Cu. Ft.	Manufacturing Date of 27-E Paver	Average Haul In Miles	Hourly Production While Paver Actually Operated		Hourly Production While Paver Operated at 100% Efficiency	
					Batches	Cu. Yd.	Batches	Cu. Yd.
1	74.47	27.00	1928	4.30	38.75	38.75	48.34	48.34
2	80.09	31.27	1929	2.30	35.49	41.11	44.95	52.07
3	88.69	27.00	1927	3.93	35.90	35.90	40.59	40.59
4	82.11	27.00	1929	1.10	37.34	37.34	43.85	43.85
5	81.32	27.00	1925	3.99	41.62	41.62	44.27	44.27
6	80.10	27.00	1926	3.14	37.40	37.40	44.94	44.94
7	81.20	27.00	1927	1.73	33.20	33.20	44.33	44.33
8	77.20	27.00	1925	1.97	39.43	39.43	46.63	46.63
9	75.00	27.00	1929	0.75	28.95	28.95	48.00	48.00
10	78.01	27.00	1929	1.63	36.01	36.01	46.15	46.15
11	67.96	27.00	1931	1.13	48.09	48.09	52.97	52.97
12	70.77	27.00	1929	1.08	47.52	47.52	50.87	50.87
13	82.10	25.67	1927	1.83	33.09	31.47	43.81	41.26
14	79.70	27.00	1927	2.62	37.09	37.09	45.17	45.17
15	80.00	27.00	1928	2.02	35.53	35.53	45.00	45.00
16	78.36	28.61	1930	3.33	37.97	40.23	45.94	48.68
17	73.07	29.73	1930	2.54	45.55	50.16	49.27	54.26
18	71.84	30.57	1930	0.88	46.62	52.78	50.11	56.74
19	76.16	28.59	1927	1.66	44.05	46.66	47.27	50.06
20	76.55	28.06	1927	4.63	40.11	41.68	47.03	48.87
21	72.55	26.81	1926	1.56	47.14	46.81	49.62	49.28
22	72.60	27.00	1927	4.35	39.91	39.91	49.59	49.59
23	72.00	28.35	1929	1.16	44.09	46.27	50.00	58.59
24	73.29	28.22	1928	7.34	45.01	47.06	49.12	51.34
25	71.61	28.30	1927	6.44	49.34	51.71	50.27	52.68
26	73.27	28.33	1930	4.50	46.92	49.02	49.13	51.55
27	79.40	30.00	1927	2.29	36.70	40.93	45.34	50.58
28	78.64	30.80	1927	1.23	37.64	42.86	45.78	52.13
29	69.32	30.80	1930	3.83	42.47	48.37	51.93	59.18
30	72.26	32.20	1930	1.90	43.73	52.18	49.82	59.45
31	81.89	31.12	1929	2.06	38.78	44.69	43.96	50.66
32	71.58	32.34	1929	2.34	37.04	44.37	50.29	60.23
33	80.00	29.99	1929	1.79	28.87	32.06	45.00	49.98
34	71.57	31.60	1930	5.55	35.99	42.12	50.30	58.88
35	78.00	27.37	1927	2.50	32.79	33.24	46.15	46.78
36	71.53	31.25	1930	6.95	37.33	43.21	50.33	58.26
37	69.50	32.24	1930	1.74	31.49	37.60	51.80	61.86
38	82.53	34.02	1927	2.15	29.41	37.05	43.62	54.97
39	71.63	33.63	1930	1.18	35.49	44.20	50.26	62.60
40	70.80	32.36	1931	2.09	45.61	54.66	50.85	60.94
41	71.93	32.40	1930	5.25	39.69	47.63	50.05	59.40
Averages	75.19	29.57		2.86	38.83	42.53	47.88	52.44

Total Production: 403,547 Batches; 441,995 Cu. Yd.

lost due to avoidable delays, twelve jobs with less than 10 per cent, sixteen jobs with less than 15 per cent, and twenty-three jobs operated with less time lost due to avoidable losses than the average of all the jobs. One may conclude that a little over half of the jobs were operated under good management.

The Mixer Cycle.—Table I-C summarizes the data relative to the mixer cycle, batch size, and hourly production. The data relative to the average mixer cycle indicate that the mixers manufactured after 1929 were faster than the ones made prior to that date. This was accomplished by redesigning, which decreased the time required to raise the skip, discharge the solid materials into the mixer drum, and to discharge the concrete from the mixer. By the purchase of the new and faster paver contractors have been able to save 10 or more seconds per batch. Even though the pavers have been developed for automatic operation, experience has proved that the need for a proficient, capable and experienced operator is as great as when the operations were conducted manually.

Fig. 4—Auxiliary Equipment Must Be Synchronized and Coordinated with the Paver. Two Finishing Machines Were Used on This Job Where the Production Averaged 54.66 Cu. Yd. Per Hour and It Was Possible to Secure 62.6 Cu. Yds. Per Hour

The difference in batch size used was caused by the state specifications and the mixer mechanical limitations. In most of the states in the Middle West the 29.7 cu. ft. batch size is allowed and used. The pavers built since 1929 can handle this size efficiently and with a net increase in production over the production obtained using the regular 27 cu. ft. batch. The average size of batch used on the jobs studied was 29.57 cu. ft.

The average number of batches mixed per hour while the pavers actually operated was 38.83 (or 42.53 cu. yd.). The maximum average number of cubic yards placed per hour was 54.66 cu. yd. If no time losses occurred the average number of batches and cubic yards

that could have been placed per hour was 47.88 and 52.44, respectively. The maximum possible production for any one job was 62.60 cu. yd. per hour—over 1 cu. yd. of concrete mixed per minute.

(*To be continued*)

▼

REPAVING IN A CONGESTED AREA

OWING to traffic conditions of location and certain difficulties encountered in uncovering the original foundation, the contract of the Parker-Schram Co. of Portland, Ore., warrants brief review. The work is known as the Ash St.-Jefferson St. unit of the Fourth Ave. section of the Pacific Highway in Portland, a State Highway Commission project.

Pulling Ties from Concrete Bed with Skimmer Rig, Showing Flat Hook under End of Chiseled-Out Tie

This contract, started June 24 and to be completed in approximately six weeks, involved repaving 12 blocks of Fourth Ave., a distance of 0.59 mile, 50 ft. between curbs. Fourth Ave. is one of the busiest of Portland's downtown arteries.

The original concrete foundation, to be saved, carried two tracks of what was at one time the Southern Pacific Railroad, covered by subsequent asphaltic concrete resurfacing. The ties of the old track were embedded to their top surfaces in concrete, with dummy strip of Belgian or stone blocks on each side of the rails.

Block by Block Construction.—In order to disturb traffic as little as possible, the work was done block by block, and as each block was prepared concreting began on the block behind. To execute the contract with reasonable dispatch, it was necessary to throw an unusually large number of men and much equipment into the two or three blocks open. In the beginning, two shifts were employed with about 20 men on the stripping and concrete and as many more on the surfacing. Later,

One Block Cleared and Ties Pulled Preparatory to Application of Leveling Course

three shifts were employed, with a total payroll of approximately 100.

The first block was used as an experimental ground and the complete routine developed there after a number of changes. This block cost the contractors almost twice as much as succeeding blocks, but in their estimation it was money well spent. The final procedure developed was as follows:

Removing Old Ties from Concrete.—Clearing of the roadbed was in three phases. (1) Removal of wood block pavement on the sides, the material being loosened and loaded into trucks by means of forks or a type 207 P. & H. Diesel skimmer rig. This exposed the dummy strip of Belgian blocks next to the rails. (2) These blocks were loosened by use of pavement breakers and the dummy strip removed with the skimmer up to the 130 lb. rails, which latter were lifted to the side by the skimmer and then removed by trucks. (3) Removal of the ties from the concrete encasement presented a problem met in this way. By means of special chisels operated with pavement breakers, one end of each tie was cut entirely out for a distance of a foot, each breaker operator and his helper doing a tie on the average in about 8 to 10 minutes. Then the skimmer rig, working just ahead on clearing operations, was backed up a short distance and with a chain and flat hook attached to the skimmer teeth hooked under the chiseled-out ends of the ties and up-ended them with a vertical pull.

Take-off operations required six trips of the skimmer up and back.

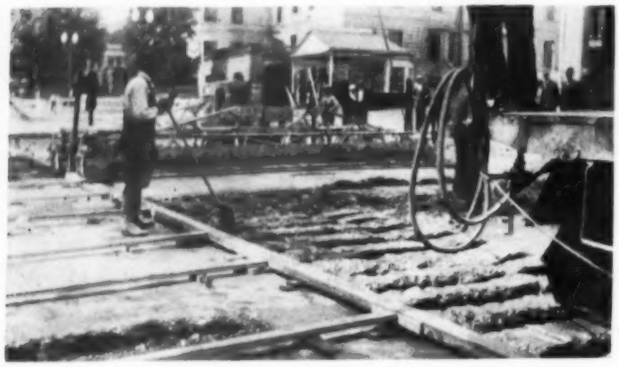
Paving Operations.—In the concreting operations, to secure the uniform 6 in. crown, new cement concrete was laid to a thickness of 3½ to 10 in., over existing concrete base, varying with the surface of the uncovered base. The center was done first, which included the tie cradles. When the concrete had taken its final set, three courses of asphaltic concrete surfacing material was applied—a leveling course of 4 in., followed by a 2½ in. base finishing course of Class A mix blacktop, and finally a non-skid course of E mix with cut-back asphalt.

Owing to traffic problems, every effort was made to keep intersections closed for the shortest possible time. Immediately after the surface of an intersection had been removed and the ties pulled, planking was laid and the intersection kept open until the cement concrete had been laid through the block behind.

Cement employed in the concrete was made by the Beaver Portland Cement Co., of a special early-set formula. One and two-thirds barrels of cement was used to the cubic yard of concrete. This mixture reached its final set in a space of three days, showing

tests of 4,200 lb. to 5,000 lb. This permitted of the application of the asphaltic materials and final completion of the street for traffic within a period of 6 to 7 days after each block was first disturbed.

Equipment.—Equipment used on the job consisted of one Model 207 P. & H. Diesel skimmer rig; one Chain



Tie Cradles Being Filled and Surface Leveled with Lakewood Screed

Belt Co. 28E "Rex" paver; Lakewood 2 screed finishing machine; one Ingersoll-Rand 370 cu. ft. portable Diesel air compressor unit; one Gardner-Denver 240 cu. ft. portable gas compressor unit; one Diesel 35 Caterpillar bulldozer; six Ingersoll-Rand Pavement breakers; one 1,030 Bucyrus-Erie gas clam shell loading concrete aggregates from barges into 3 scale Butler weigh batcher; and Parker-Schram Co. 3,000 lb. Madson asphaltic concrete paving plant on North Front Ave.

▼

Passenger Cars Use 1 Gal. of Oil to 30 Gals. of Gas

A survey made recently by the American Petroleum Institute's Department of Statistics reveals that in 1934 passenger motor vehicles consumed 1 gal. of oil to every 29.78 gals. of gasoline, motor trucks consumed 1 gal. of oil to every 35.95 gals. of gasoline, and motor buses consumed 1 gal. of oil to every 57.70 gals. of gasoline.

The vehicles covered in the survey were those operated by fleet owners, and while the survey reflects geographically average conditions and permits of a study of consumption of fuels and lubricants by vehicles in constant use, it is not regarded as reflecting average per vehicle consumption. For instance, this survey revealed an average annual gasoline consumption of 2,002 gals. per vehicle, whereas estimates have placed the general average at 665 gals.

Efforts to ascertain the consumption of transmission and differential oils indicated a ratio of 1 gal. of oil to every 505 gals. of gasoline consumed. The consumption of grease for chassis lubrication was estimated at 1.56 lb. per 100 gals. of gasoline consumed.

Following are results of the survey in tabular form:

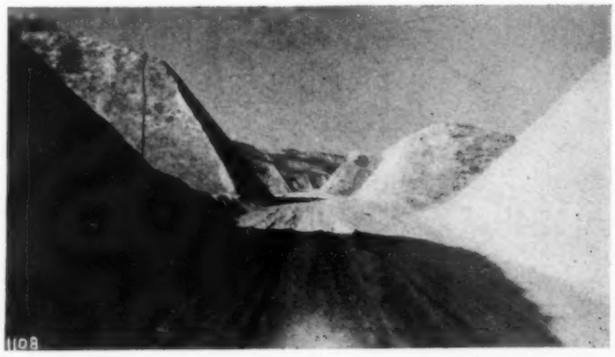
Classification	No. Vehicles Reporting	Ratio of Gasoline to Oil (Gallons)	Per Cent Oil to Gasoline
Passenger cars	8,657	29.78 to 1	3.36
Trucks	11,184	35.95 to 1	2.78
Cars and trucks	4,270	41.78 to 1	2.39
Busses	2,175	57.70 to 1	1.73

1,200,000 Cu. Yds. Dirt Moving in 6¼-Mile California Road Job

Construction is now under way on a state highway contract in Riverside County in Southern California that involves the handling of 1,200,000 cu. yds. of

One of the Big Fills in the "Jack Rabbit" Trail Contract

material on a 6¼-mile job. One strip 3 miles in length, through the most precipitous section, contains 800,000 cu. yd. of excavation. One station alone requires the



Line-up of Cuts on "Jack Rabbit" Job. Six Cuts Are Shown in the Illustration

moving of 60,000 cu. yd., and a single fill will take 175,000 cu. yd. The greatest cut, at an upper cut stake, shows 185 ft. to grade. The dirt moving is being han-

Some of the Scrapers Working on the Job

dled by 30 Le Tourneau scrapers. The 12-yd. scrapers are worked tandem—two being hauled by a 75 tractor. The contractors are Mittry Bros. and Crow Bros.

A LOW COST METHOD FOR IMPROVING RESIDENTIAL STREETS

By JOHN H. AMES
City Manager, Ames, Iowa

THE City of Ames, Iowa, has sought some method of construction for residential streets which would permit the improvement of the parkings, be free from the objections of mud and dust, provide for permanent drainage of the street and would cost materially less than the higher type of pavements. This year the city has undertaken the construction of three miles of such street construction using a concrete curb and gutter with "stabilized gravel" base and a bituminous mat wearing surface. The construction is completed except for the bituminous wearing surface and already petitions for approximately two additional miles of this construction of the same type have been received.

What the Improvement Program Includes.—The improvement program includes the installation of a concrete combined curb and gutter, the excavation of the old street surface between the gutter slabs; the construction of the gravel base course consisting of a 3-in. layer of pit run gravel and over this, a 3-in. layer of stabilized gravel. The 6-in. base course is thoroughly compacted by rolling and by the action of traffic after which it will be covered with a thin bituminous wearing surface. The base course is designed to provide suitable load carrying capacity for residential street traffic and the top coating of bituminous material will provide a satisfactory wearing surface free from objectionable dust conditions. The estimated cost of the base course and bituminous mat, including excavation, is 65 cts. per square yard.

How the Improvement Is Paid For.—Under a plan approved by the City Council, improvement of streets by this method was undertaken on all streets on which the property owners were willing to pay for the curb and gutter installation. This cost is estimated at $1.00 per foot of frontage on each side of the street, and is payable to the city over a 10-year period, the city having issued street improvement bonds to cover the expense of this part of the improvement. The cost of the excavating and of providing the new street surface is borne by the city from general funds. Thus the total direct cost of the improved dustless street to a property owner having a 50-ft. frontage is approximately $50.00 payable over at 10-year period.

Streets which are being improved for the most part are cinder streets in residential sections where the traffic at this time is not heavy enough to warrant the expense of paving, but where dust has been highly objectionable. Some doubt about the desirability of the new type surface existed when the plan was first proposed but as soon as several stabilized surfaces had been completed,

A Stabilized Gravel Street Preparatory to the Addition of Bituminous Surfacing—Brookridge Avenue Near Lee Street

After Excavating to a Depth of 6 In., the Base Course Was Carefully Smoothed by the Blade

petitions for extension of the work to more streets began to come in. Work was begun in May and although the bituminous surface is not to be applied until early fall, the stabilized course has compacted to an almost concrete-like state, already benefiting residents and motorists by greatly curtailing the dust nuisance and providing a smooth driving surface.

Construction Details.—In this construction, we are using a curb and gutter installation which is 8 ins. thick at the road edge, 6 ins. at the curb edge with an 18-in. gutter. The existing road surface is excavated to within 2 ins. of the bottom of the gutter slab, thus providing for a 6-in. fill. For the first 3 ins. of fill, ordinary gravel with a maximum size of 1½ in. is used. The top 3 ins. is stabilized material consisting of gravel, clay, and calcium chloride, applied in layers and thoroughly compacted with a roller. This course is brought to a level with the surface of the gutter slab at the edge and given a 6-in. crown in the center of the street.

Stabilized Mix Made in Concrete Mixer.—An innovation in the construction method which has attracted considerable attention is the use of a concrete mixer to provide the stabilized mix. In undertaking this construction, we wished to minimize as much as possible the dust nuisance during the construction period. We therefore decided against the usual method of pulverizing the clay and mixing the material on the road and instead set up a central mixing plant at the edge of the city, using an ordinary 15-cu.-ft. concrete mixer for the purpose. The operation has been entirely satisfactory and has been so dustless that in the future I would not hesitate to use a portable mixer on the street.

At the mixing plant, the desired mix is obtained by proportioning the gravel and clay as it is dumped into the skip. In this instance this is being done by the use of wheelbarrows, since we desired to use hand labor wherever possible. About eleven men were employed at the mixing plant which turns out about 200 cu. yds. of material in ten hours.

Central Mixing Plant for Combining Gravel, Pulverized Clay and Calcium Chloride

Clay Pulverizer at Brick Plant.—The clay which is incorporated in the stabilized mixture is obtained from a brick plant nine miles distant. This clay has a plasticity index of about 35, according to soil tests made by the standard method. The clay is pulverized in the dry pan mill of the brick factory and is delivered to our mixing plant finely pulverized, having a texture similar to that of Portland cement. Because of its high plasticity index, only about 11 per cent of clay is added to the gravel to give a finished mixture having a plasticity index of 13. The clay is delivered at the plant ready for mixing at $2.70 per cubic yard.

The Gravel.—Both the clay and gravel are stock piled at the mixing plant. The gravel is obtained from a nearby pit which is equipped with a portable crushing and screening plant. Specifications on the gravel for the stabilized course call for 100 per cent passing a 1-in. sieve, 50 to 75 per cent passing a ⅜-in. sieve, and not less than 45 per cent nor more than 55 per cent passing a No. 8 sieve. When mixed with the clay, this provides a mixture falling within the standard specifications for stabilization. Tests are run on the gravel about every ten loads.

Pulverized Clay, Obtained from a Brick Plant, Was Used in Mix at the Rate of About 11 Per Cent by Volume

Incorporation of Calcium Chloride.—The calcium chloride which is incorporated in the mixture to supply and retain the moisture bond necessary for maximum compaction is added at the rate of ½ lb. per 1 in. of thickness per square yard. In mixing at the plant this amounts to about 2.3 cu. ft. of clay to 16 cu. ft. of gravel for every 10 lbs. of calcium chloride. By determining the capacity of the wheel barrows, the mixture is made in the skip, providing a very satisfactory control over the mix. The time required for mixing is about one-half to three-quarters of a minute per batch handling ¾ cu. yd. of material. No water is used in the mixing, but with a concrete mixer the operation is absolutely dustless.

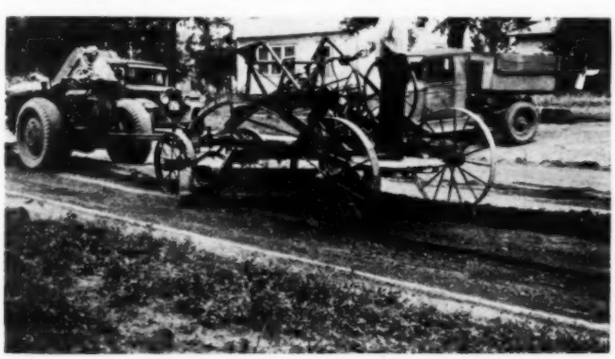
Placing Stabilized Gravel.—From the mixer, the material is dumped directly into trucks and hauled to the streets on which the base course gravel has been previously applied. Considerable care is exercised in obtaining a smooth grade and the base course gravel is

The 3-in. Gravel Base Course Was Thoroughly Rolled Before the Stabilized Mixture Was Placed

thoroughly rolled before the stabilized mixture is placed. The stabilized gravel is then windrowed along the sides of the street until it is spread over the surface in thin increments and shaped by the blade. It is then thoroughly sprinkled and rolled with a 5-ton roller. To aid compaction, we also make a practice of sprinkling the streets for several days after the stabilized material has been placed, and continue shaping them with the blader until they become too hard to make this operation practicable.

The surface obtained by this method is a dense, highly compacted mat which it is difficult to dig into even with a pick-axe. Within a very few days, our streets have compacted to such a degree that they can best be described as "soil pavement." While the streets are not shaped to have as much crown as we would give them if they were to be maintained as stabilized surfaces, they shed surface water readily and are so tightly bound that there is practically no loss of material by washing. We expect this stabilized course to withstand the impact of traffic, thus furnishing an ideal base for the thin bituminous mat. With the curb and gutter installation, the appearance of the streets is greatly improved adding to the attractiveness of the residential areas, and we believe this type of improvement with the stabilized wearing course is admirably adapted to the residential districts. It provides a dustless, all-weather street at low cost.

While this project was not undertaken primarily as relief work, in addition to the eleven men employed at the mixing plant, it is giving employment to approximately seventeen men with trucks and to twelve men who assist in the fine grading and in the grading and spreading of the material. It was desired to use as much hand labor as possible and still keep the cost close to the estimate. This cost could be materially reduced by the use of more mechanical equipment with the proportional reduction in hand labor.



Hauled to the Streets by Trucks, the Stabilized Mixture Was Spread and Shaped by the Blade

Painting San Francisco-Oakland Bay Bridge

After more than two years of debating, architects and engineers have finally agreed on aluminum paint as a final coating for the new San Francisco-Oakland Bay Bridge; in fact, painters are already at work on the giant span.

The complete paint system for the bridge involves several paints. Over the bar steelwork goes two coats of rust inhibitive red lead, followed by an intermediate base coat of black graphite paint. The aluminum field coat concludes the job.

Applying Final Coat of Aluminum Paint to One of the Towers of San Francisco-Oakland Bay Bridge

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The Future of American Cities

The future growth of American cities was the subject of an interesting discussion by C. A. Dykstra, city manager of Cincinnati, Ohio, at the Annual Convention of the American Water Works Association held in that city May 6-10. Mr. Dykstra gave the opinion that the coming trend will be away from the increased growth of the larger cities, while the decentralization of industries will result in the growth of small cities into places designed for living as well as working.

In a world of machines, Mr. Dykstra said, cities must necessarily disintegrate and die if the loss of purchasing power by individuals continues. This situation necessitates a genuine and basic interest in the yield value of land and a reduced speculative interest in real estate developments. City expansion, vertically, will slow up, slums will disappear and population will become static if it does not decline absolutely. The coming city was pictured by Mr. Dykstra as one that avoids over-industrialization, and also one characterized by homes which afford an opportunity to mix recreation with work in a proper proportion. The work of the engineer in planning such a city of the future is of paramount importance.—*Public Works Engineers' News Letter.*

PEORIA PLANS FOR TOMORROW'S STREETS

By CHARLOTTE S. ASHMAN
Chairman, City Planning Commission, Peoria, Ill.

A PLAN to stop waste in the development of an adequate major street system and which will provide convenient and economic vehicular movement within the city has been adopted by Peoria, Illinois. The plan is based on a thorough analysis of existing conditions, present trends and probable future needs.

As with all other cities, financial limitations necessitate that a comprehensive improvement program be gradually developed over a long period.

C. W. A. Aids in Survey.—Peoria's traffic survey was undertaken as one of the city's planning projects with the aid of employes furnished by the C. W. A. Counts were taken between intersections during a 12-hour period from 6 a. m. to 6 p. m. on week-days only. Stations were carefully selected that the effect of important intersecting streets upon traffic flow could be checked. Counters were located at each station along a selected street that variations in volume of daily traffic could be noted.

Complete results of the survey were recorded as illustrated in Table I.* From this table the basic data for preparation of other tables and plans were obtained.

A composite picture of all traffic on the streets which were studied is shown in Table II. Columns 1 to 10 are self-explanatory. Column 11 is the assumed average width of pavement. Column 12 is the ratio of the total hourly traffic for all stations to the assumed pavement width shown in column 11 and indicates the average number of vehicles per hour per foot of pavement width.

Comparative Data for Major Streets.—From Table I data were prepared and compiled as shown in Table III.† Columns 1 to 6 are self-explanatory. Column 7 shows the hourly average for each station. Column 9 is the maximum hourly traffic. Columns 8 and 10 are respectively the ratios of columns 7 and 9 to the total hourly traffic. Column 12 is the ratio of the hourly average to the paved width of the street and indicates the actual number of vehicles per foot of paved width per hour.

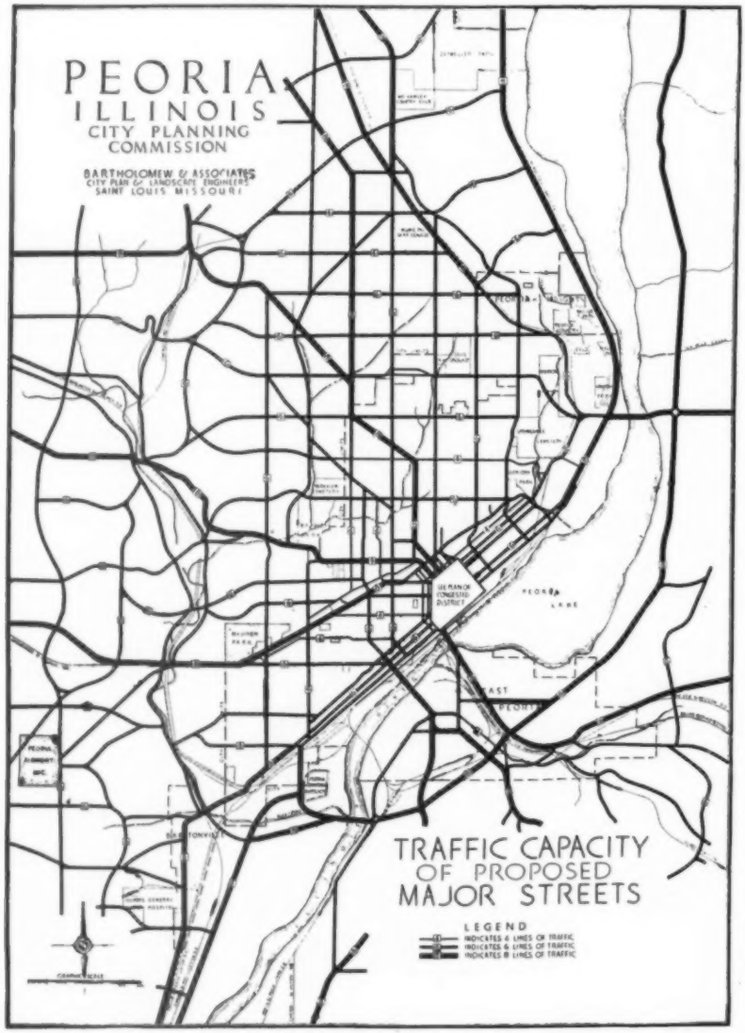
By comparing ratios, a picture of the relative adequacy of the streets may be gained. Heavy duty streets are shown both with respect to number and type of vehicles. Study of these data shows that while the average ratio for the city is 6.2 vehicles per hour per foot of paved width of street, some streets have ratios as high as 39.5 and many streets have ratios over twice the average ratio for the city.

To help visualize the data obtained in the traffic survey, maps were prepared showing the traffic flow on respective streets of the city, and on the streets entering and leaving the business district. A chart was also prepared showing the half-hourly traffic variation from 6 a. m. to 6 p. m. From this study a proposed major street plan was prepared to serve as a guide in future street improvement programs. A map was also prepared which showed the traffic capacity of proposed major streets.

Interesting facts which the traffic flow map reveals are that the old Franklin Street bridge still carries the largest number of vehicles; the small amount of crosstown traffic, particularly in the area north of the business district, and similar facts.

Turning the light of facts on the central business district, traffic concentrations are readily located and points where improved facilities are needed may be determined.

The report is concluded with the following:



Traffic Capacity of Proposed Major Streets

*This table included counts from all the stations and hence is much too long to be introduced here. Thus results from only the first six stations are given.—Editor.

†This table contained data for 14 major streets. Three only are shown in our table.—Editor.

"It is not intended that the improvements outlined be considered to the exclusion of any other projects, but that they should at least receive favorable consideration among any others that are suggested. Any program that is adopted may necessarily be subject to change from time to time and it is therefore recommended that similar traffic surveys be made yearly to provide a sound basis for considering any modification of improvement program or the adoption of future programs."

Building Line Regulations Important for Street Program.—After determining a program of future street improvements, steps were necessary to facilitate the carrying out of proposed work without unnecessary expense. Since the proposed program would cover an extended period of years, regulations controlling future growth, with building line regulation, were vital. Street widenings are unusually costly only when existing buildings are affected by the new street lines, and have to be torn down, remodeled, or moved back. Any procedure that will prevent new and expensive buildings from being erected within the future street lines will thus insure great financial savings to the community.

Building line regulations also are important in improving the health and safety of citizens.

Recommendations are made in the major street plan concerning location and desirable width of those streets which will adequately accommodate future vehicular movement. The complete system as proposed serves all portions of the city and when ultimately improved will accommodate the majority of vehicular traffic. Many other streets within the city will thus carry only a small amount of local traffic. No widening or extensive improvement are necessary upon them.

Building Line Ordinance Adopted to Facilitate Future Street Plan.—A building line ordinance was therefore adopted as a definite scheme in facilitating future street improvement. This will assure ultimate completion at a minimum cost. Building lines, based upon definite needs, are thus established upon a comprehensive system rather than upon piecemeal projects selected at random. The completed system will play an important part in improving the city for the benefit of all citizens.

Before drawing up the building line ordinance, plans were prepared by CWA employes, showing existing conditions along each street upon which building lines were to be established. The data shown include the present width of the street; the location of all buildings fronting or siding upon the street; the height of the building and type of construction; and the assessed valuation of the land and improvement.

Detailed study was then given the possible location of the building lines so that the street could be eventually widened in a manner that would be most equitable and advantageous to all interests.

General Principles for Location of Building Lines.—General principles followed in determining the detail location of the building lines were:

1. "In most cases the building line regulations are to control the location of buildings over a long period. Since they do not disturb existing structures, any new and reconstructed buildings can gradually be set back.

TABLE I.—SUMMARY OF TRAFFIC COUNT

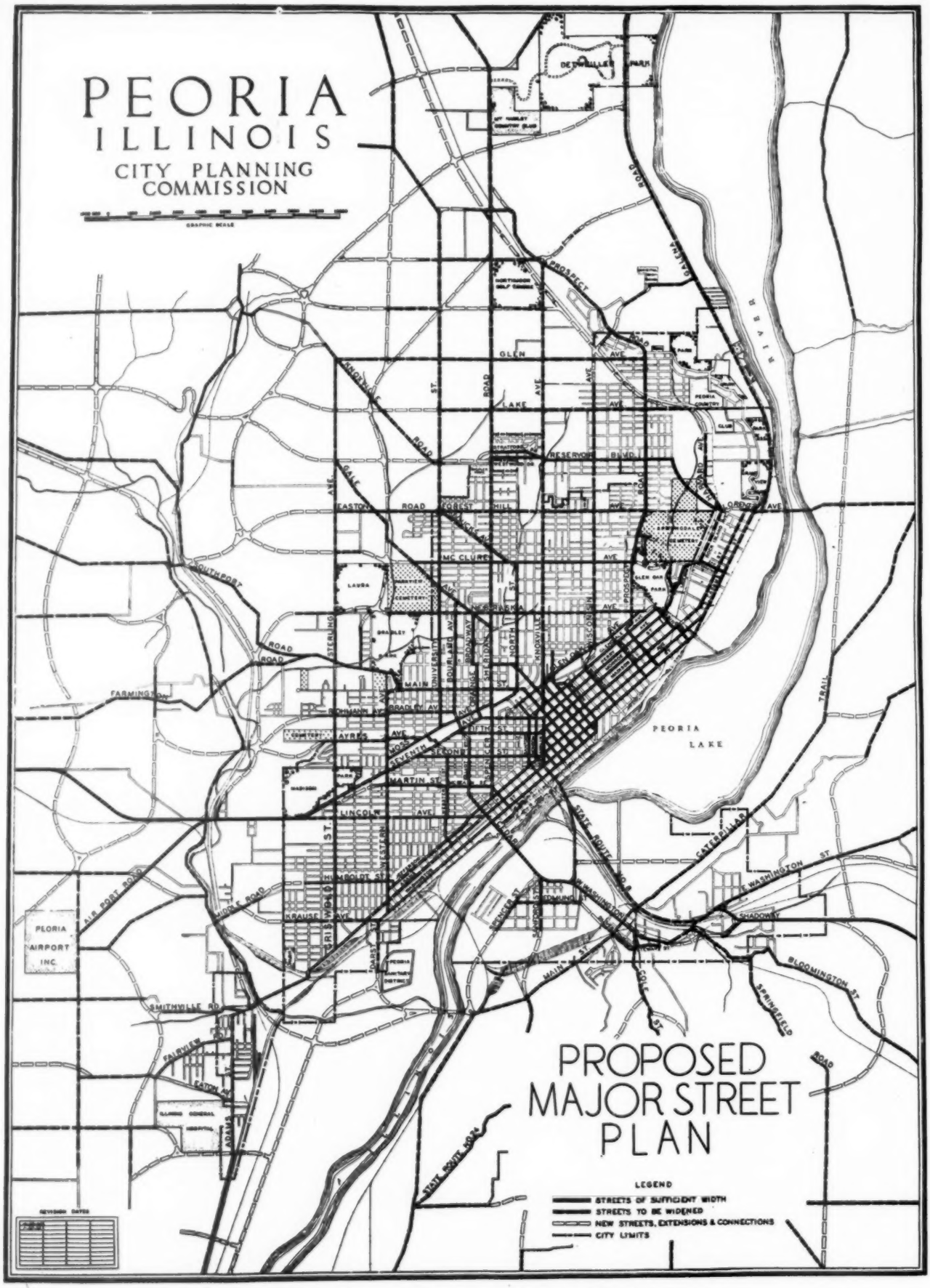
Sta. No.	Street	Between	Maximum Hour		12-Hour Period from 6 a. m. to 6 p. m.								
			Hour	Traffic	Autos	%	Trucks	%	Busses	%	St. Cars	%	Total
139	Abington	(Jefferson-Madison)	4:30 to 5:30	46	184	44	62	15	174	41	...	..	421
105	Abington	(Perry-Pacific)	7:00 to 8:00	38	149	60	95	40	...	..	...	..	244
47	N. Adams	(Fayette-Jackson)	3:30 to 4:30	412	2,665	79	439	12	72	2	265	7	344
91	N. Adams	(Voris-Spring)	3:30 to 4:30	462	2,567	68	952	26	5	..	233	6	3,757
92	N. Adams	(Camblin-Park)	4:30 to 5:30	371	2,137	76	642	21	188	3	...	..	2,967
18	N. Adams	(Harvard-Lorentz)	4:30 to 5:30	223	1,276	70	383	20	186	10	...	..	1,845

TABLE II.—SUMMARY OF TOTAL TRAFFIC COUNTS

Total Traffic 12 hrs.	Total Autos 12 hrs.	% of Autos	Total Trucks 12 hrs.	% of Trucks	Total Busses 12 hrs.	% of Busses	Total St. Cars 12 hrs.	% of St. Cars	Total Hourly Average	App. Paved Width	T.H.A. P.W.
1	2	3	4	5	6	7	8	9	10	11	12
377,940	296,529	78.5	69,830	18.5	3,899	1.0	7,754	2.0	2,186	35	6.2

TABLE III.—COMPARATIVE DATA ON THREE PRINCIPAL MAJOR STREETS

Street	Between	% Autos	% Trucks	% Busses	% St. Cars	H.A.	H.A. T.H.A.	M.H.T.	M.H.T. T.H.A.	Paved Width	H.A. P.W.
1	2	3	4	5	6	7	8	9	10	11	12
Knoxville Ave.	(Main and Glendale)	87.0	13.0	....	....	503	2.31	755	3.46	48	10.4
	(Glendale and Glen Oak)	83.5	13.0	....	3.5	857	3.93	1,136	5.21	42	20.0
	(Glen Oak-Col. Terr.)	85.5	10.5	....	4.0	741	3.40	951	4.36	42	17.6
	(McClure-Archer)	85.0	12.0	....	3.0	544	2.49	695	3.18	45	12.0
	(McClure-Virginia)	84.5	12.0	....	3.5	463	2.12	616	2.82	45	10.2
	(So. of Lake Ave.)	79.0	21.0	....	....	121	.55	180	.82	45	2.6
	Average Totals....					538	2.46	722	3.31		
Main St.	(Perry-Knoxville)	82.0	13.0	....	5.0	1,180	5.41	1,673	7.67	60	19.6
	(Knoxville-Glendale)	80.0	10.0	....	10.0	670	3.07	1,025	4.70	60	11.1
	(Glen Oak-Crescent)	82.5	12.0	....	5.5	677	3.10	937	4.30	60	11.2
	(Sheridan-Ellis)	80.0	15.0	....	5.0	518	2.38	717	3.29	40	12.9
	(University-Ellis)	78.0	19.0	....	3.0	390	1.79	680	3.12	40	9.7
	Average Totals....					687	3.15	1,006	4.61		
N. Adams St.	(Fayette-Jackson)	79.0	12.0	2.0	7.0	287	1.31	412	1.88	60	4.7
	(Voris-Spring)	68.0	26.0	....	6.0	313	1.43	462	2.11	50	6.2
	(Camblin-Park)	76.0	21.0	3.0	....	247	1.13	371	1.70	40	6.1
	(Harvard-Lorenz)	70.0	20.0	10.0	....	154	.70	223	1.02	40	3.8
	Average Totals....					250	1.14	367	1.68		



Proposed Major Street Plan for City of Peoria, Ill.

Thus, existing developments should not completely dictate the location of the future street lines.

2. "It was generally attempted to establish building lines of equal depth on each side of the street, but in certain instances, when expensive development and shallow lots could be avoided, greater depth would be established on one side than on the other.

3. "Consideration was given the depth or width of the lot upon which the building line was established, so that a reasonable amount of building space would be available.

4. "Wherever necessary, slight variations in alignment were introduced. They were made gradual rather than abrupt, so that the general appearance of the street will not be affected adversely.

5. "Other factors considered, included topographical features, zoning regulations, and the probable cost of eventually acquiring the necessary land."

Frontage Affected by Building Line Regulations.—An analysis of the frontage affected by the building line regulation is of interest. Building lines are established on major streets comprising 73.01 miles of frontage. Of the total frontage 24.11 miles, or 33 per cent, is now vacant, and any new structures can readily be located back of the established line; 32⅜ miles, or 43 per cent, is developed with structures that are already set back, and will not be affected by the regulation; only 16.52 miles, or 22.7 per cent, is now developed with structures that will eventually have to be set back. Furthermore, the 16.52 miles represents lot frontage and not the actual frontage of the structures. In many instances, particularly in the residential districts, the building represents only a small per cent of the frontage affected. This is valuable evidence in determining the reasonableness of the regulation. It also indicates the desirability of adopting the regulation before additional frontage is developed with structures projecting to the existing street line.

Forty-three and one-half percent of the total mileage of major streets included within the major street system are now of adequate width. There are also 2.88 miles of new connections and extensions, the majority of which could be obtained by sub-division regulations. Very few large and expensive structures are affected by the building line. The majority of the buildings affected are dwellings, many being obsolete and of little value.

The major provisions of the building line ordinance are that no portion of any new building shall be erected in the area between the building lines and the present street lines. Any existing building now extending between the building line and the street line can continue to be used and need not be remodeled or changed so as to conform to the required set-back. But no such building can be remodeled or altered so as to continue its use beyond its natural life.

The building commissioner will administer the ordinance. For unusual conditions where application of the ordinance may impose severe hardship upon the property owner, a board of appeals, created by the zoning ordinance, may review the facts and allow certain modifications where deemed absolutely essential. The board has no authority to change location of the building line or erase any regulation of the ordinance, but only to interpret the provisions and permit minor variations thereof.

Where changing conditions make a change in regulations or in location of the building line necessary the ordinance provides that changes and amendments may be made by the city council. Wholesale changes are insured against by requiring that a public hearing be held and that a report be made by the planning commission presenting the desirability of a proposed change.

The data developed by CWA employes and other employes of the City Engineer's office were assembled under the direction of E. O. Pearson, engineer for the Peoria City Planning Commission. Harland Bartholomew and Associates of St. Louis were consultants.

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New Types of Brick Pavement Fillers to Be Tested

The new types of fillers for use in brick pavement construction that were developed in the laboratory of the Research Bureau of the National Paving Brick Association at the Ohio State University Experiment Station will be tested in actual service in a brick pavement now under construction under the supervision of the U. S. Bureau of Public Roads and the Ohio Highway Department on Ohio Route No. 31, the Columbus-Athens Road in Hocking and Fairfield counties. There will be fifteen sections of brick pavement each about 500 ft. in length in which different varieties of fillers will be used. Following is an outline of the tests that will be made and the observations that will be recorded.

1. Exuding of filler.

2. A comparison of traffic effect on a brick surface course. A large number of coal trucks carrying five or more tons use this road to carry coal to Columbus. These trucks travel light going to the mines and use the other lane going north when they are loaded. The two lanes can easily be analyzed to determine the effect of heavy loads.

3. Temperature gradient through brick-cushion-base and sub-grade and a determination of the protective effect of brick surface courses on a concrete base. No factual information is available on the temperature gradient through the various parts of a brick road.

4. Tractive resistance of motor vehicles on brick surfaces as related to the amount of exuded filler. This will be a continuation of an investigation by Professors Stinson and Roberts of the Mechanical Engineering Department of Ohio State University as reported to the Highway Research Board.

5. Determination of whether separating agents affect the adhesion of the filler material in the joints. In connection with the use of "plastic sulfur," a new separating agent (an old-water emulsion), will be tried. Data relative to the effectiveness and cost of using this material will be obtained.

6. A study of the moisture proof qualities of a surface course of brick.

7. A record shall be kept of the temperature of the heating kettle and occasionally of the temperature of the filler as poured from buckets. The surface of the filler should be chilled with water at several points and the effect of shrinkage in the joints on exuding noted. At various points brick should be removed from the finished pavement to note the penetration of filler in the joints.

In addition to those listed above, it is proposed to devise a test to determine the amount of stress and impact that is absorbed by a brick surface course. The details of this test have not yet been fully worked out and it will be performed first in the laboratory on brick pavement panels.

Design and Construction of the

Wellston Bridge—July 11, 1935

WELLSTON BRIDGE
Over South Branch of Manistee River

By L. B. HENDERSON

Project Engineer

CONSTRUCTION of the high-level Wellston Bridge was started the latter part of June, 1934, by the Michigan State Highway Department under the general supervision of Murray D. Van Wagoner, State Highway Commissioner.

The bridge is unusual in design and location. The project is located on Route M-55, 24 miles east of Manistee, and crosses the south branch of the Manistee River. The crossing is between the Tippy Dam and the Stronach Dam, both owned by the Consumers' Power Company, and is one of the most beautiful scenic spots in Michigan.

The Tippy Dam forms an artificial lake 3 miles long, with the bridge located in the center of a horseshoe bend in the tail end of the backwaters. The ground is practically flat from the river bank to a distance of 400 ft. on the east side and 600 ft. on the west side. It then rises sharply to form high bluffs approximately 100 ft. above the water. A high-level bridge was necessary to overcome a hazardous grade, which was the main objection to the old roadway.

East Pier and Abutment—January 6, 1935

The substructure contract, including the piers complete and the abutments to El. 737.71, was awarded to the Owen-Ames-Kimball Company of Grand Rapids; the contract for superstructure, to the Wisconsin Bridge & Iron Company of North Milwaukee.

Abutments.—The bridge substructure consists of two reinforced concrete piers and two reinforced concrete abutments of the frame type. The west abutment has a height of 64 ft. 3½ in. from the bottom of footings to the top, a width of 47 ft. 7 in., and is 34 ft. 6 in. long parallel to the bridge. It is constructed with 6 reinforced concrete columns which are tied together with reinforced concrete struts. One set of struts is 20 ft. above the top of footing, and the next set 37 ft. 8½ in. above the top of the footing. This forms a frame almost identical to the frame of a reinforced concrete building, and allows the dirt to spill through, thus relieving the earth pressure. On top of this frame are placed three lifts of heavy reinforced concrete walls which form the wing walls of the abutments. These are also tied together with struts, and each lift is set back from the one below. The columns are carried on spread footings and the footings are carried on treated timber piling. Each footing has 25 piles supporting it. These were jetted down through the sand to hardpan and were then driven to bearing capacity.

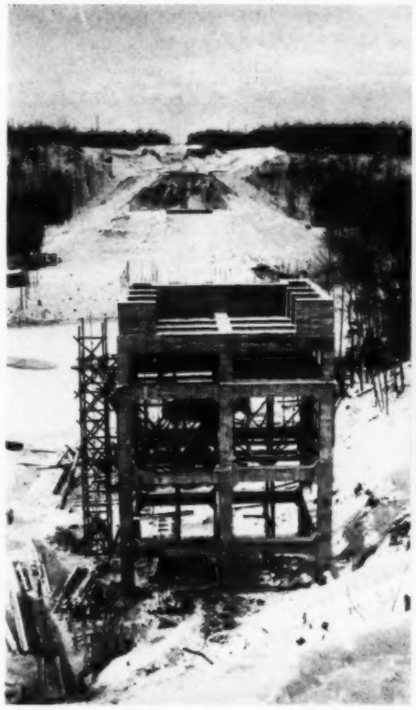
The east abutment is similar to the west. It is on lower ground, however, and the use of piling was not required as the clay hardpan was near the surface. The east abutment has one lift more than the west, and is 80 ft. 9½ in. from the bottom of the footings to the top of the abutment.

Piers.—The footings of the piers are 47 ft. long, 22 ft. wide, and 4 ft. thick. Their bottoms

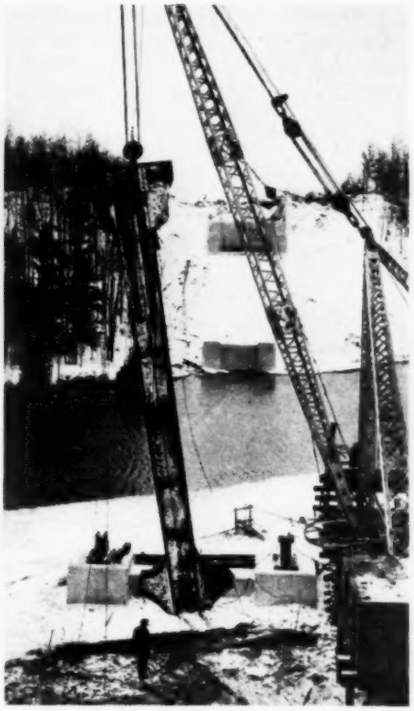
are 23 ft. below normal water level and are anchored in clay hardpan. Considerable difficulty was encountered in driving the steel sheet piling for the cofferdams due to the hardness of the clay. The work was accomplished by digging out from under the bottom of the sheeting with air spades for 3 or 4 ft. and then driving. This operation was repeated until the sheeting was driven below the bottom of the footings. Practically all the materials in both piers had to be dug with air spades, loaded in steel buckets, and hoisted out with the crane.

Each pier is 35 ft. high from the bottom of the footings to the top of the pier. About 5 ft. of the west pier and 12 ft. of the east pier are exposed to view.

Temporary Trestle.—In order to get heavy equipment and material, including a 35-ton crane, to the site of the project, the Owen-Ames-Kimball Company constructed a timber trestle 280 ft. long across the river from the south, the only accessible road. Timber piles were driven in 18 ft. of water.



East Abutment—November 20, 1934



Erecting the First Column

Superstructure.—The superstructure of the bridge consists of two 125-ft. steel anchor arms, two 125-ft. cantilever arms, and a 50-ft. suspended span in the center. This permits a clear span over the river of 300 ft. and a distance between the abutments of 550 ft. The two concrete-frame abutments which form the approach roadway to the bridge are 32 ft. long at the top. This makes the overall length of the bridge 614 ft. The distance from the normal water elevation to the bridge floor is 73 ft.

The bridge is designed so that the two piers carry the entire load. The ends of the bridge have an upward reaction at all times and are anchored down with eye bars. These eye bars are connected to the top chord of the anchor arm trusses with 4-in. steel pins. The bottom ends of the eye bars are also connected to the anchor beam with 4-in. steel pins. The anchor beams are concreted into the abutment, and are located 17 ft. below the center of the top chord. A lateral lock is provided in the abutments to prevent lateral displacement at the ends of the bridge.

Bearings.—The bridge is carried on four cast annealed bearing shoes, two on each pier. The shoes weigh 3½ tons each, and are set on 3/16 in. lead plates and anchored with bolts set in the pier concrete. The top of the shoe carries 11-in. steel pins, which in turn carry the main posts. These posts are 27 ft. 6 in. long and weigh 20 tons each.

Expansion Joints.—At each end of the suspended span provision is made for a 2½-in. expansion joint. This allows 5 in. for expansion in the center of the bridge. As the steel expands or contracts, the construction allows the main posts to rock on the bearing pins and the ends of the anchor arm move on the pin connections there. Expansion joints are provided between the concrete slab on abutments and the concrete slab of the bridge floor.

Width.—The roadway has a clear width of 30 ft. between curbs. A 2½-ft. sidewalk for pedestrians is provided on each side. The approach railing on the

Anchor Arm Construction—April 8, 1935

Construction April 22, 1935, Looking Easterly

abutments is of reinforced concrete with Indiana limestone cap. The railing on the bridge is constructed with 132 sections of ornamental iron, 66 on each side, with concrete posts between sections.

East Cantilever Portion—April 10, 1935

Stairway Connections.—One of the unusual features of the bridge is a reinforced concrete stairway, 4 ft. wide, at each right hand approach. The stairs are carried down the sides of the abutments on reinforced concrete brackets, and extend to a point where the bottom chord of the anchor arm steel arches into the abutments. From this point a winding path will lead down the side slopes, giving motorists access to the river.

The roadway fill around the abutments is approximately 60 ft. high. The road contract provides for sodding the side slopes.

Engineering and Contractors' Staffs.—The bridge was designed by L. W. Millard, Bridge Engineer, and J. H. Cissel, Design Engineer, for the Michigan State Highway Department. The writer was the Project Engineer and worked directly under J. H. Flynn, Engineer of Bridge Construction.

Harold F. Mead was superintendent for the Owen-Ames-Kimball Company on the substructure work. Archie Price is superintendent for the Wisconsin Bridge & Iron Company on the steel erection. On July 31 the structure was practically completed, except for painting and erection of the railing.

West Abutment—July 15, 1935

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Pennsylvania Starts Grade Crossing Elimination

On July 29, Pennsylvania took the first steps in its $11,485,613 Federal fund program to eliminate dangerous curves and grade crossings.

Warren van Dyke, secretary of highways, announced that preliminary details were worked out that day at a conference between highway department engineers and representatives of the Pennsylvania Railroad.

It was explained that contracts between field engineers of the highway department and the railroads will be set up to speed the work.

Laboratory Tests of 3-Span Reinforced Concrete Arch Bridges

The investigation described in Bulletin No. 270 of the Engineering Experiment Station of the University of Illinois, entitled "Laboratory Tests of Three-Span Reinforced Concrete Arch Bridges with Decks on Slender Piers," by Wilbur M. Wilson and Ralph W. Kluge, which has just been issued, consisted of tests of a three-span arch series on high piers, each span being composed of a rib with spandrel columns and a deck. For one structure the deck was a considerable distance above the rib at the crown of the arch; for a second structure the deck was so low to be integral with the rib at the crown. Each structure as originally built had no expansion joints in the deck, except over the piers. After each structure had been tested expansion joints were cut in the deck near the one-third point of each span, and the resulting structure was again tested. The structure with a high deck, both with and without intermediate expansion joints, was tested at pier heights of 20 ft., 15 ft., and 10 ft., respectively; the structure with a low deck was tested at a pier height of 20 ft. only.

Among the objects of the investigation was the obtaining of the following information relative to the structures described:

(a) The magnitude and position of the thrust due to the design load.

(b) The maximum carrying capacity of the three-span structure.

(c) The effect of intermediate expansion joints in the deck on the load-carrying capacity of the structure.

Among the results obtained were the following:

(a) There was considerable evidence that the dead-load stress in a multiple-span structure may exceed the corresponding stress in a similar span having fixed ends.

(b) The effect of the deck was to reduce the moment at the springing due to the load, where it is all resisted by the rib, and to increase the moment over the middle of the span, where the deck acts with the rib.

(c) A deck without intermediate expansion joints increased the stiffness and the moment-resisting capacity of the central part of the structure; intermediate expansion joints reduced both of these effects.

Until Jan. 1, 1936, or until the supply available for free distribution is exhausted, copies of Bulletin No. 270 may be obtained without charge upon application to Engineering Experiment Station, Urbana, Ill.

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PEAK TRAFFIC ON NEW JERSEY HIGHWAYS.—The traffic survey of the state highway system of New Jersey, conducted from August, 1932, to August, 1933, showed that peak traffic exceeded 50,000 vehicles per day on the Philadelphia-Camden Bridge and was more than 40,000 per day at other locations. Routes leading to shore resorts had the highest ratios of maximum daily traffic to average daily traffic. Near Weymouth on N. J. 42, the ratio exceeded 700 per cent and ratios in excess of 500 per cent were found southeast of Cedar Bridge on N. J. S-40 toward Long Beach and on a county route connecting with Atlantic Highlands southwest of New Monmouth. These ratios are of special signficance in considering pavement width and right-of-way width requirements. Eighty-four sections of highway throughout the State were found with ratios of peak to average traffic in excess of 300 per cent.

THE 40TH ANNIVERSARY OF THE ELECTRON

By HALBERT P. GILLETTE

IN EVERY branch of science there are epochal dates. In astronomy five are very noteworthy: 1543 when Copernicus published his heliocentric theory of the solar system; 1609 when Kepler published "Astronomia Nova," expounding his three laws of planetary motion; 1610 when Galileo reinvented the telescope and first put it to use, in a study of the heavens; 1687 when Newton published his immortal "Philosophica Naturalis Principia Mathematica," in which the law of gravitation was deduced and applied; 1814 when Fraunhofer discovered spectral lines, thus leading to the invention of the spectroscope, a machine scarcely second to the telescope in the astronomical knowledge that it has enabled man to secure.

Let us consider for a moment another epochal discovery that has become invaluable not only to astronomers but to scientists in almost every branch of physics and chemistry, namely, the discovery of the electron. In 1895 Sir J. J. Thomson showed that when an atom is partly disintegrated, certain products of the disintegration are identical, no matter what kind of atom they come from. They are identical in mass and in electric energy. At first he called them corpuscles, but later the name electron was adopted. The electron carries the unit-charge of negative electricity.

It is amazing to read the many quantitative applications of the electron theory that developed within 20 years of Thomson's epochal discovery. The last 20 years have piled even greater amazements upon those of the first 20, until it is probably not putting it too strongly to say that not a single branch of physical science will fail to be profoundly affected by electron theory within the next 20 years.

Take, for example, meteorology which has been dominated by the thermal theory from its inception down to date. Already it is well known that electrons, and their positive partners, the protons, act as nuclei of rain drops. After Franklin flew his research kite in 1751 the world learned that electricity has its residence in the clouds as well as in the earth, but it was then supposed to exist in the clouds because it was developed there by friction. Although 184 years have elapsed, the electric charges of clouds are still generally regarded as effects and not as causes of storminess. Yet it is not unlikely that men have been mistaken all this time. Here and there a scientist has suggested that electricity or its affiliated magnetism or both may be an important causitive force in meteorology. In 1855 Faraday argued that magnetic forces may create winds. The electron was not then known—not till 40 years later—or Faraday would probably have seen in it a sort of energy capable of performing great work in the atmosphere.

I regard the electron as being not only a master worker in the air and in the ocean, but in the molten core of the earth, and by that I mean that it causes important currents in all three of these fluids. It is well known that the earth is constantly emitting electrons in excess of protons. It is well known that electrons moving in a magnetic field travel in spirals around magnetic lines of force. It is well known that circular currents exist both in the air and in the ocean, and that their causes have long been debated. Usually thermal convection has been regarded as the primary cause of all air currents, but there have been several different explanations of how those currents become circular, and how circular whirls often manage to maintain themselves after moving long distances from their birthplaces.

Shortly after Marconi's astounding achievement in sending a radio message across the Atlantic had nonplussed the physicists, Kennelly and Heaviside independently explained the achievement upon the hypothesis that a shell of electrified air exists at a considerable elevation, which, by reflecting radio waves, enables them to travel around the curved surface of the earth. That was in 1902. Since then at least one other similar electrified shell has been discovered, and "radio echoes" indicate the existence of several more. The radii of the latter often exceed the distance to the moon. That they are shells of electrons seems practically certain in view of the constant emission of electrons from the earth. Analogy strongly points toward the existence of similar electron shells surrounding every heavenly body. If so, these shells rotate and are magnets. Being rotating magnets their axes must gyrate under the influence of magnetic force, just as the earth's axis gyrates under gravitative force. Once this inference is made a flood light is thrown upon the cause of weather and climatic cycles. Then it also dawns upon us that even the great crustal uplifts that have accompanied every Ice Age may have been caused by cyclonic electron whirls in the molten core of the earth. Still later it becomes evident that in these rotating electron shells satellites probably developed, for electrons emitted from a gaseous star must have carried some of its molecules along. Even the tangential velocity of these shells, and consequently of planets developed from the molecules in them, is explainable from the principle of magnetic rotation, as is also the axial rotation of the planets.

Electrons escaping from the sun must carry with them some of its molecules. Hence the rate at which it loses mass is probably far greater than is indicated by the rate at which its mass is being converted into energy. Hence the life of the sun and other stars is probably far briefer than has been estimated hitherto. Every star is probably surrounded by an atmosphere of emitted electrons of vast diameter in which exists a series of electron-shells spaced at regular intervals. It can be easily shown that this spacing is such as to form a geometrical progression series of diameter whose ratio is two. Bode's empirical law of planet distances then becomes rationalized, and it leads at once to the conclusion that when the planets beyond Mercury were generated in those electron-shells, the sun's luminous sphere was the electron-shell where Mercury was afterward developed! And this, in turn, indicates that giant-stars are luminous electron-shells of vast diameter surrounding cores of great mass; and that dwarf-stars are luminous electron-shells of relatively small diameter, like that of our sun at present. The smallest dwarf-stars may have no luminous shell at all, but may be luminous masses of molten matter. Much that is puzzling about giant and dwarf-stars may thus be explained. Some of the remaining stellar mysteries may be solved by considering the effect of vast stellar atmospheres of

electrons, for light waves passing through those atmospheres must have their spectral lines shifted toward the red end of the spectrum. Many spectral shifts that are now attributed to the movement of stars in a direction away from us, and others that are attributed to stellar gravitation (the Einstein shift) will probably be found to be due to neither of those causes but to the electrons that pervade all space and to those that exist in electron-shells or pour forth in dense streams from the gyrating poles of electron-shells.

There is an impressive body of evidence of the existence of a geological cycle about 26,000 years long, or about the length of time that is consumed in a complete gyration of the earth's axis. Since the magnetic effect of the sun upon the earth is a maximum when their axes have the same longitude, it follows that a climatic cycle of about 26,000 years must exist if displacement of the terrestrial electron-shells affects our weather. This would not have been suspected had Marconi's invention not led to the discovery of an ionosphere; and such shells in turn, would not have been suspected had the electron remained unknown.

There is considerable geological evidence of a climatic cycle about 40 times 26,000 years in length. Since the pole of the ecliptic gyrates in about that period, it follows that its gyration may explain that cycle. Finally there is a geological and climatic cycle several million years long. Analogy suggests that it results from gyration of the sun's axis. So the three longest climatic cycles disclosed by geological strata and by paleontological data seem to result from the gyrations of three axes, two of which are known to gyrate and the third of which, that of the sun, must also gyrate according to established physical laws.

When Thomson was knocking electrons out of atoms in his laboratory 40 years ago, little could he have dreamed that those midgets of matter—1840 of which are required to balance one atom of hydrogen—might one day serve to explain both climatic and geological cycles, not to mention the genesis of stars and their satellites.

"There are more things in heaven and earth, Horatio,
Than are dreamt of in our philosophy."

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U. S. Approves 700-Mile Minnesota State Road Program

A year's program of nearly 700 miles of trunk highway construction, submitted to the United States Bureau of Public Roads recently by N. W. Elsberg, State Highway Commissioner of Minnesota, has been approved by the federal authorities. Approximately $6,300,000 will be required to carry out the approved projects, of which the national government will pay half in the form of regular, matched federal aid. A list of additional projects involving about $500,000 is awaiting federal approval and will complete the program.

The highway department will begin letting contracts for the work whenever the State Executive council authorizes the sale of highway bonds to meet the state's share of the cost. This method of financing was provided by the last Legislature. Another construction program of equal size can be carried on next year by the matching method, as Minnesota has been allotted nearly $7,000,000 of regular federal highway aid for 1935 and 1936.

Included in the program already approved by the federal roads bureau is 120 miles of concrete paving, 216 miles of grading with gravel lifts, 220 miles of heavy gravel surfacing, 22 miles of bituminous surfacing, 19 bridges and a quantity of miscellaneous work.

Book Review

Building Lines and Reservations for Future Streets by Russell VanNest Black. 257 pages, octavo, with plates, diagrams and tables. $3.50 postpaid. Harvard University Press, Cambridge, Mass.

Practically every city and town in this country is concerned with the problem of adapting its eighteenth or nineteenth-century street system to twentieth-century conditions by some method of remodeling old street patterns and widths as well as by protecting new streets from encroachments during the interval between plan and achevement, with a minimum of destruction and expense.

In the latest volume of the Harvard City Planning Studies, Mr. Black has made a summary and analysis of the various methods of approach to this problem that are being employed in the United States. He has based his inquiry upon questionnaires, field visits, and voluminous correspondence with administrators and planning practitioners, together with an investigation of all available literature, enabling legislation, and court decisions having a direct bearing upon the subject.

After an introductory chapter in which the author clears away much of the confusion on this subject, he proceeds to consider legislative and administrative aspects of building lines and street reservations, local procedure and experience, and the relative merits of procedures based on eminent domain and on the police power; he compiles and analyzes the most significant court decisions, and summarizes the economic aspects of the question. The statement of his conclusions is so clear and practical that it will be of great help to city planners and to all officials having contact with the many phases of this problem. His bibliography lists practically all the written material in the field. He adds excerpts from model legislative forms, state legislation, and city and county ordinances.

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Publication on Bridge Piers Available

Bridge Piers as Channel Obstructions, by David L. Yarnell, Senior Drainage Engineer of the Bureau of Agricultural Engineering, has recently been published by the Department of Agriculture as Technical Bulletin No. 442.

This bulletin presents the results of numerous experiments on the obstruction of bridge piers to the flow of water. It describes test procedures used and develops coefficients for different shapes of piers using larger piers and a more extensive range of conditions than has hithertoo been attempted. The four bridge pier formulas most commonly used in the United States are discussed.

The bulletin contains numerous illustrations, charts, and applications of the bridge pier formulas to test and theoretical conditions.

Copies of this publication may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 10 cents each.

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Rural Road and House Numbering System

A uniform plan for marking rural roads and residences in Indiana has been prepared by the State Division of Rural Rehabilitation under the Governor's Commission on Unemployment Relief, and has been adopted by a number of counties in the state. The plan provides a combination of letter and number markings, whereby rural residences may be found in the same manner that residences are found by number in cities.

USE OF ROCK SALT IN STABILIZED ROAD CONSTRUCTION

IN recent years there has been a rapidly growing demand for a low cost type of road, primarily designed to carry lighter traffic. These secondary roads serve as feeders to, and connections between, the main highways, and may be divided into two general types—the floating surface type and the soil-stabilized type. The floating surface type is constructed by adding loose gravel or other hard material to the graded road bed. Because the loose or floating material is cast aside by traffic, these roads require almost constant maintenance by blading. The usual procedure is to scrape the gravel to the center of the road with a highway machine. Passing traffic soon scatters the material and scraping must be repeated at frequent intervals.

Characteristics of Soil Stabilized Roads.—In soil-stabilized roads, the gravel or coarse material is imbedded and held in place by a fine material containing clay which acts as a binder. They present a hard, smooth riding surface, and require less maintenance than ordinary earth roads and floating type roads.

A soil-stabilized road consists of a compacted wearing course of suitable thickness, composed of such materials as gravel, broken stone, slag, sand and natural soil binder, which includes fine sand, silt and clay. These materials are either pre-mixed or mixed in place in proper quantities and proportions to give all-weather stability.

Requirements.—Stable soil roads should be laid and compacted to conform to a satisfactory grade, typical cross-section and finished surface. The requirements of stable soil mixtures are based upon studies of the United States Bureau of Public Roads, co-operating with the several State Highway Departments. The following table gives the percentages by weight of the various materials:

Coarse aggregate—gravel or coarse material whose screen size is larger than No. 10. No stones larger than one inch should appear on the surface. Use up to 60 per cent of graded material.

Coarse sand—between No. 10 and No. 60 size sieves. Use 20 per cent to 25 per cent.

Fine sand—between No. 60 and No. 270 size sieves. Use 10 per cent to 15 per cent.

Silt and clay—finer than No. 270 size sieve. Use 10 per cent and 25 per cent.

Action and Behavior of Materials.—The principal advantage of this type of road is that the wearing course is composed of hard materials on which traffic is really borne—gravel, crushed rock or slag—firmly bound together. The coarse aggregate and coarse sand furnish structural strength, hardness and friction. Fine sand adds imbedment support to coarse sand. Silt acts as a filler to prevent the granular particles from rocking. Clay and colloidal particles provide close texture in which the pores are so minute that connecting moisture films surrounding the materials are sufficiently thin to produce high cohesion.

Sand and clay provide a natural stabilizer for roads, with a high supporting value in addition to high cohesion. Clay, however, is subject to fairly wide limits of expansion and contraction when alternately dampened and dried by rain, wind and sunshine. In a roadway, untreated clay shrinks as it dries. This permits imbedded coarse aggregate to become loose and make a floating surface. The dry clay then turns to dust and blows away or is cast aside by traffic. It is necessary, therefore, to maintain a constant supply of moisture in the clay particle in order to have them maintain their maximum cohesiveness.

Research and Data.—A few years ago in an effort to reclaim arid soils for agricultural purposes, peculiar phenomena were observed from the effect of salt on clay. This was reported in Technical Bulletin No. 12, University of Arizona, College of Agriculture. Recent research has indicated that salt improves the stabilizing effect of clay. In order to secure accurate scientific data, Dr. H. Ries, professor of geology at Cornell University, cooperated in conducting research in this direction. Among the tests conducted were the plasticity, volume, shrinkage, field moisture, permeability, and capillary movement of moisture in various salt-clay mixtures and salt-soil-stabilized mixtures. A voluminous report from Dr. Ries, verified by results obtained in actual roads, gives in detail the scientific data to substantiate the following conclusions:

1. Salt does not appreciably change the cohesion of clay as shown by the fact that it does not materially alter its plasticity.
2. Upon drying, salt-treated clay and soil-stabilized mixtures shrink much less than those not treated with salt.
3. The moisture retaining quality of the clay is decidedly increased by treating it with salt.
4. As water evaporates from the surface of salt-

A Salt-Stabilized Farm-to-Market Road in New England.

soil-mixtures, minute crystals of salt form a dense, hard crust which closes the pores and retards further evaporation.

5. Salt added to clay produces some coagulation of clay particles, which means that in a stabilized road the rate of capillary action of soil moisture is slightly increased, and moisture films are more evenly distributed throughout the mass. The resultant effect is that salt aids materially in the compaction of soil, thus producing greater density.

6. When water falls upon the surface of a salt-treated, stabilized road, the surface salt is dissolved. Brine thus formed sinks below the surface. The clay in the surface swells somewhat, and being freed of most

Close-Up of a Finished Road Surface.

of its salt, some of it disperses or breaks up into the very fine colloidal condition—an effect peculiar to salt alone. This expanded clay and finely divided or colloidal material stop up the pores and tend to prevent further percolation of water downward from the surface, thus forcing excess water to drain from the road.

Coagulation of clay and recrystallization of salt again take place in a salt-treated road as drying occurs and the salt brine creeps to the surface.

This research indicated that salt-clay soils have a much more effective supporting and binding power than natural soils. Actual road construction in various parts of the country during the past three years, has proved by practical experience the effectiveness of rock salt for road stabilization.

The general effect of salt-treated clay in roads is to conserve the moisture in the clay, preventing excessive shrinkage and pulverization, thus holding the coarse aggregate firmly in place. Salt-soil roads, because of excellent compaction and crystallization of salt in the surface and more or less permanent effects of the salt on the clay, somewhat resemble concrete in appearance and resistance to abrasion and have almost the close texture of bitumen.

These results are obtained largely because salt attains its greatest stabilizing effect as an admixture, and not merely as a surface treatment. This extends the moisture holding condition throughout the entire body of the salt stabilized layer. Being mixed with the aggregate, the salt remains in service for a long time, and need not be replenished by frequent additional applications.

On the surface of a salt-treated soil road, the clay becomes practically impervious when it has absorbed a small amount of water. The crystallized salt and its effect on clay make a hard surface crust which inhibits further sub-soil evaporation, but which in turn will shed water. This aids in maintaining a moist condition in the wearing course and keeping the sub-soil in a uniformly damp condition, thus securing and retaining the maximum support and cohesion from the clay, silt and sand. It is practically impossible to wash or leach all of the salt or its effect out of clay.

Types of Road Stabilized.—In general, there are two principal types of road upon which stabilized wearing courses may be constructed. Type one is the common earth road with little or no gravel. This type of road will require all stabilizing material to be brought in from some outside source, unless the clay in the road is uniformly suitable to stabilize the gravel.

Type two is the well established gravel road. If analysis shows that there is sufficient material in the old road, excepting, perhaps, the proper proportions and uniformity to fulfill the requirements of the stabilized wearing course, the road may be scarified to the desired depth, over-size stones removed, and additional material added, if required, either from the shoulders or ditches or from a separate source of supply.

Materials and Construction.—The stabilized wearing course should be at least 3 in. thick. Regardless of total thickness, it is not necessary to add salt to more than the top 3 in. The salt-treated layer must rest upon a substantial, well drained and compacted base course. The base course should be provided with a slight crown to assist drainage. In grading, all sharp curves should be properly banked.

The materials for construction of the wearing course should conform to specifications and recommendations issued by the United States Bureau of Public Roads, which apply to all stabilized roads regardless of the stabilizing agent used. The mixture of materials should be so proportioned that when compacted there will be an interlocking of granular particles and sufficient capillarity to furnish high stability during wet weather and enough cohesion in the soil binder to prevent the surface from disintegrating during wet weather.

Materials falling within the following composition limits by weight should produce good results:

Passing	Per Cent
1-in. screen*	100
¾-in. screen	85 to 100
⅜-in. screen	65 to 100
No. 4 sieve	55 to 85
No. 10 sieve	40 to 65
No. 40 sieve	25 to 50
No. 270 sieve†	10 to 25

Typical Cross Section of a Salt-Soil Stabilized Road.

Material larger than 1 in. may be used, but not to exceed 10 per cent of the total quantity of the aggregate, and the size should never exceed one-third the thickness of the stabilized layer. The fraction passing the No. 270 sieve should be less than two-thirds the fraction passing the No. 40 sieve. The percentage of fine soil to be used will vary with the plasticity or

*All sieves for grading materials must have square openings and for No. 4 and finer must conform to the United States Standard Sieve Series. See A. S. T. M. Standards, Part 2, page 1145 (1933).

†Standard Hydrometer test, ordinarily used by the United States Bureau of Public Roads for mechanical analysis, may be used instead of the No. 270 sieve.

cohesiveness and the character of the clay. Fine soil—soil binder—is that portion passing the 40 mesh sieve. It includes the clay, silt and fine sand.

The fraction passing the No. 40 sieve shall have a plasticity index between 1 and 15 and a liquid limit not exceeding 35, as determined by the physical test methods of the United States Bureau of Public Roads.‡

Generally plasticity indexes of about 3 or less provide sufficient cohesion for unusually wet conditions; 4 to about 8 for average moisture conditions, and 9 to 15 inclusive for dry or arid conditions.§

Choice of materials will be governed largely by local conditions. Usually suitable clay can be found in the vicinity of the project. Experience shows that the best roads are those which conform most accurately to the above requirements.

Run of bank gravel is sometimes satisfactory for the construction of wearing courses without adding clay. Often clay from shoulders, ditches or local clay banks must be added to run of bank gravel to meet the requirements for gradation and laboratory analysis.

When the road bed has been prepared, clay or gravel, or both are deposited in proper quantities to stabilize the material in place or in correct proportion and amount to form the entire stabilized layer. All stones larger than 1 in. should be raked either to one side or removed to the sub-base and spread evenly over the center line to be covered by the stabilized wearing course. No larger stones should appear near the surface.

The clay, when sufficiently dry, is pulverized with whatever means available—traffic, harrows, disks, bladers or rollers, by proper manipulation on the base course or elsewhere. When the clay is dry and pulverized, it is thoroughly mixed with the gravel forming the stabilizing material. This is sampled for uniformity and gradation, evenly spread over the base course, shaped by blading and compacted by rolling or traffic or both, so that the finished road has a cross slope of not more than ¾ in. or less than ½ in. per foot, as shown in the accompanying diagram. The surface should always have sufficient slope to assure adequate drainage.

The rock salt may be spread over the surface material and thoroughly mixed with it before compaction in a single layer or it may be added in successive layers with the aggregate while building up and compacting the wearing course. The quantity of salt recommended is approximately 2 lb. per sq. yd. of road surface and will vary from 8 tons per mile for a road 14 ft. wide to 12 tons per mile for a road 20 ft. wide.

Salt-soil-stabilized wearing courses compact best to a dense hard surface when the total moisture content is approximately 15 per cent to 20 per cent of that portion passing a No. 10 sieve and termed soil mortar. In some cases, construction can be planned so that finishing operations will occur when the clay contains the proper amount of natural moisture. The amount of water required for best compaction is more than sufficient to dissolve all of the salt.

In very dry weather a properly moistened surface will "set up" in less than a day and require little additional attention. It is important that the surface be maintained in a satisfactory condition during the initial "setting up" period until it becomes sufficiently hard to resist rutting by traffic.

‡See "Public Roads," Vol. 12, No. 8, October, 1931.
§See "Public Roads," Vol. 15, No. 12, February, 1935.

Spreading Clay to Be Pulverized and Mixed in Place

Curing and Maintenance.—Just as concrete roads require a period of curing before they are suitable for heavy traffic, stabilized roads need final consolidation through compaction by traffic during what may be called a period of seasoning, following construction.

After salt-soil-stabilized roads become compacted, no frequent blading routine or other maintenance is necessary. The surface is so well compacted that it is difficult to pick it loose and it is not easily cut by ordinary means when dry or slightly moist. In the spring and during and immediately after prolonged wet weather, the surface will soften sufficiently to permit the addition of salt and blading for smoothing out irregularities. This permits bringing in material from the shoulders to act as a binder for any loose aggregate that might have become dislodged.

When natural abrasion makes it necessary to repair the surface a coat of standard material (aggregate, clay and rock salt) ½ in. thick containing 4 tons of salt per mile is applied, using ordinary construction methods. Damp standard construction material makes a satisfactory bond with the worn surface without scarification.

Coarse Salt Desirable.—The coarser grades of rock salt are especially well adapted for use in mixing with stabilized road materials. Because of their size and hardness they remain free flowing and distribute more uniformly than evaporated salt from shovels, trucks or mechanical spreaders.

Rock salt dissolves slowly in soil mixture and maintains a reserve of undissolved salt to replace that which is unavoidably lost during the years that constitute the life of a road. Since natural rock salt is similar in texture to road materials, the undissolved portion remains an integral part of the aggregate.

Pioneer research in the use of rock salt for soil-stabilized roads in the United States was sponsored by the International Salt Co. in cooperation with state, county, township and municipal highway officials. The International Salt Research Laboratory, Ithaca, N. Y., conducted the investigations.

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Motor vehicle and gasoline taxes in Great Britain total about $350,000,000 per annum, of which about $125,000,000 is appropriated for roads, while the remainder is combined with other tax revenue for general purposes.

A LARGE ALL-WELDED BRIDGE IN NEW JERSEY

Riverside-Delanco Bridge Over Rancocas River, New Jersey, May 31, 1935.

PROBABLY the largest truss bridge ever built in the United States by welding, and probably one of the two largest all-welded truss bridges in the world, was completed early in June across the Rancocas River, between Riverside and Delanco, New Jersey. The shielded arc process of electric welding was used.

Built at a cost of $270,890, this bridge is 397 ft. long with a roadway 36 ft. wide between curbs and one sidewalk 5 ft. wide from center line of truss to center line of hand rail. The width of the bridge, measured from center to center of trusses is 38 feet 6 inches. The bridge is supported on two abutments, two intermediate piers and one center pier.

The Two Gasoline Engine Power Plants Which Supplied Current for the 9000 *Feet of Field Welds*

There are two fixed approach spans and one swing span. Each fixed span measures 112 ft. 8 in. center to center between end bearings, with two spaces 4 ft. 6 in. long over the piers. The swing span is 160 ft. long. These spans, totaling 385 ft. 4 in. in length, added to 9 ft. for the two spaces over the piers, and two spaces totaling 2 ft. 8 in. between center line of end bearings and back wall, make the total length of the bridge 397 ft.

Each approach span truss was fabricated complete in the shop by arc welding. The swing span trusses were also shop-fabricated, each being welded up in three sections, which were later field-welded into a single truss.

The use of arc welding, principally in the chord and web members of the trusses, permitted a weight saving estimated as between 10 and 15 per cent of the structural steel of the bridge. As built, the weight was 450 tons.

A total of 24,000 linear ft. of welding was required in fabricating and erecting the structural steel. Of this amount 15,000 ft. of 5/16 in. full fillet welds were required in the shop fabrication, all of which was done by the American Bridge Company at Ambridge, Pennsylvania. The field welding, which amounted to 9000 linear ft. of 5/16 in. full fillet welds, was done by the J. K. Welding Company of New York City. Shop fabrication was done with motor generator type of welding equipment while gas engine driven machines were used in the field. The equipment and electrodes used in both shop and field welding were manufactured by The Lincoln Electric Company, Cleveland, Ohio.

The contract for the Riverside-Delanco bridge was let January 29, 1934, to the Kolyn Construction Company of Trenton, N. J. Contract for the superstructure was sublet to the American Bridge Company and the contract for the field welding was sublet to the J. K. Welding Company, New York City. Construction Engineers on the project were the Bridgeweld Engineering Company, New York, represented by H. B. Mish of New York City.

Two of Three Sections of One Truss of Swing Span Delivered at the Bridge Site Ready for Erection

PREVENTION OF FROST HEAVING IN ROADS

By HERMAN H. MILLER and DON N. SMITH

Road Stabilization Department, The Dow Chemical Company, Midland, Michigan

CONSIDERABLE interest was aroused by the publication of a report in the June, 1934, issue of ROADS AND STREETS on "Prevention of Road Failures Due to Frost." Through continued work on this subject, additional information is now available in this article. However, a very brief review of the previous work will be worth while.

Previous Work Reviewed.—In the spring of 1933, observations were made on Michigan State Road No. 20 extending west from Midland. Locations which broke

Fig. 1—Section of M-20 During Spring Break-Up of 1934

up badly due to frost action were referenced to highway hub stakes along the road. In the fall of the same year, numerous places were selected for experimental purposes. Holes having a depth of 30 in. and a diameter of about 12 in. were placed in the road. Various spacings were tried, but it developed that for effectiveness and economy the holes should be about 6 ft. apart. When staggered in four rows parallel to the centerline, there were 68 holes per 100 lin. ft. of road. These holes were dug with welfare labor using picks and shovels. A mixture was then made using two parts by volume pea gravel and one part calcium chloride. The holes were filled within 4 in. of the surface and then finished with gravel which was stabilized with an admixture of clay and calcium chloride.

The value of this work was well demonstrated in the spring of 1934. With no exception, every area which was treated remained dry and firm while the surface in both directions from the treatment became soft and badly rutted, in most cases right up to within about 4 ft. of the calcium chloride gravel-filled holes.

Additional Sections Undertaken.—In the fall of 1934, additional sections were undertaken. This was done with the idea of getting comparisons with work done the previous year, as well as eliminating frost boils in numerous places. Fig. 1 is a view of such a location photographed in the spring of 1934. This area was treated in the fall of the same year. Figure 2 was taken at the same place in the spring of 1935 at a time when other untreated portions of the road were badly broken up.

There was one portion of the road about seven miles west of Midland which had been unusually bad. In the spring of 1933, heavy planks were laid over a large area. The worst portion extended over a section of about 500 ft. in length. In October, 1933, calcium chloride and pea gravel-filled holes were placed in the second and fourth 100-ft. stretches. The following spring those two sections remained dry and hard while the three adjacent areas rutted badly. In the fall of 1934 the center 100-ft. section was treated. The result was that in the spring of 1935 the whole 300-ft. in the center were in excellent condition, while the 100-ft. stretches on each end were soft and broken up. This not only showed the effectiveness of the treatment, but demonstrated that it would last for at least two seasons. In Fig. 3, the white line shows the beginning of the treated section which went through two spring break-ups. The contrast with the untreated area in the foreground is quite apparent. The photograph was taken even after considerable repair work and blading had been done on the untreated road.

Method Tried by Counties and Highway Organizations.—Following the general procedure outlined in the previous article, a number of Michigan counties as well as highway organizations in other states tried out this method of eliminating frost trouble in their gravel roads. The results were all satisfactory except on one section of road in one county. On that particular job ordinary maintenance gravel was used instead of pea gravel and the holes were only 15 to 24 in. deep. In other sections of the same county the same treatment was employed except pea gravel was used, and beneficial results were

Fig. 2—Section of M-20 During Spring Break-Up of 1935. Treated Area Remained Firm While Untreated Sections Which Failed in Previous Years Were Very Soft and Badly Rutted As in the Past

obtained. It is impossible to say positively just what caused the poor results in the one location, but it may be that the gravel was too dense to accommodate sufficient calcium chloride or that the holes were not sufficiently deep.

Power Drill Used.—During the first two seasons of experimental work, hand labor was used exclusively. This resulted in a cost of about $0.50 per hole or $34.00 per 100 lin. ft. of road treated. In order to cut down on costs, it was decided that tests should be run using machine methods. A Buda-Hubron earth drill mounted on a 4-wheel trailer was procured for the purpose. The drill helix assembly was 12 in. in diameter. A few sections were completed using this equipment. It was found that the machine could average 45 holes per hour. Since the machine moves very easily, a pick-up truck or any light car can easily move it from place to place. Two men were used to operate and move the equipment. Two other men with a 2 cu. yd. dump truck mixed the materials and filled the holes. The mixing was done in the truck box and a supply of patching gravel was carried along to cap the holes when finished.

Figure 4 shows the power equipment and three stages of operation. At the left is the drill and the hole which has just been dug. In the middle is a hole filled with calcium chloride and pea gravel, ready for capping. At the right is the completely treated spot, filled and capped with stabilized gravel.

Cost.—In comparing the methods, it was found that with a power drill the work could be done for $0.40 per hole including the cost of all materials, labor and rental on equipment, as shown in Table I:

TABLE I

Pea gravel @ $1.50 per cu. yd.	$0.04 per hole
Calcium chloride @ $19.50 ton	0.25 per hole
Labor @ 50c per hour	0.05 per hole
Rental on equipment @ $2.70 per hour	0.06 per hole
Total	$0.40 per hole

This results in a cost of $27.20 per 100 lin. ft. of road or a saving of $6.80. It should also be noted that the $0.50 per hole, using hand labor was accomplished under favorable conditions. In the event that the work was done late in the fall or early winter, the depth of frost would be sufficient to slow up production and raise the cost of labor. This would show a more favorable balance for machine labor. Of course, under present economic conditions many highway organizations prefer using hand methods to help carry the welfare load.

Fig. 3—Junction of Untreated Area and Section Treated 2½ Years Previously

Due to the interest and the satisfactory results obtained with the treatment of gravel roads, further work to eliminate frost hazards and destruction on hard surfaced roads will be undertaken by our Road Stabilization Department. Results of such additional experiments will be reported at a later date.

Fig. 4—Treatment of Road for Prevention of Frost Heave

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Prof. Steinberg to Head Educational Division A. R. B. A.

Charles M. Upham, Engineer-Director of the American Road Builders' Association, announces the selection of Professor S. S. Steinberg, Head of the Department of Civil Engineering at the University of Maryland, to serve as President of the newly organized Educational Division of the Association.

The purpose of the new division is to promote closer relationship between the highway industry and the educational institutions; to advance highway engineering education by making available to college faculties and students in highway courses the facilities, organization and bulletins of the Association, to the end that the practical information at its disposal may be utilized in the training of the future leaders of the highway industry and profession; and to promote studies in highway economics so that the value of our highway systems may be made manifest and the funds available may be spent most effectively.

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Halbert P. Gillette Honored by National Highway Traffic Association

Halbert P. Gillette, editor of ROADS AND STREETS and president of the Gillette Publishing Company, has been elected Honorary President of the National Highway Traffic Association. The purposes of this association, as set forth in its articles of incorporation, are:

The advancement of the art, economics and science of highway transport in its several branches and the fundamental engineering sciences related thereto; the dissemination of information and knowledge pertaining to highway transport; the professional improvement of its members; the encouragement of intercourse between men with mutual interests in highway transport; and the establishment of a central point of reference and union for its members.

EDITORIALS

Highways—Out of the Fire

The American Road Builders' Association and Current Developments

THESE are strenuous times for the American highway program. Friends of good roads find themselves compelled to work between a long-range, adequate, normal highway development goal on the one hand and emergency unemployment relief problems on the other.

Briefly, the background of current developments, and the pressing problems of the day, together with the solutions of some of these, may be presented as follows:

The highway program was squarely in the fire at the beginning of 1934. Foes of better roads were demanding a holiday in highway building. From many quarters came demands that all normal operations be scuttled in favor of quick, make-shift work projects designed exclusively for millions of idle hands, regardless of the permanence of work done. Some States were losing interest in Federal-aid funds that must be matched, and an increasing number of States were diverting gasoline taxes and motor vehicle revenues into channels other than road building and maintenance.

The American Road Builders' Association, always a central stabilizing influence in the campaign for adequate highways, declined to abandon the normal highway program in favor of make-shift expediency. With the Association's cooperation, the Hayden-Cartwright Act of 1934 was drafted and guided through the log-jam of legislation that attended the 73rd Congress.

This Act appropriated $450,000,000, of which $200,000,000 was an outright grant to the States, and $125,000,000 was designated as Federal-aid for this year and an equal sum for next year, thus stabilizing the highway program for a three-year period.

After the $4,880,000,000 Emergency Relief Act of 1935 was introduced, Senator Hayden and Representative Cartwright, again working closely with the American Road Builders' Association, succeeded in incorporating into the bill an amendment whereby the $800,000,000 which was designated for highway construction and grade crossing elimination and protection would be apportioned by the regular Federal-aid formula, and administered by the State Highway Departments and the United States Bureau of Public Roads.

However, administrative rules and regulations invoked for the expenditure of these funds limited the outlay for roads and grade crossings to $1,400 per man-year of work, including cost of materials. This throttled the contemplated highway and grade crossing program, for no permanent work could be done under such limitation of expenditures.

The American Road Builders' Association presented the situation to its members, and to members of Congress and officials of the Administration. It was pointed out that the contemplated highway program was headed for disaster unless the rules and regulations were modified so as to permit greater latitude in expenditures.

This concerted action by the highway industry and profession resulted in the approval by President Roosevelt of revised rules and regulations under which States could "travel" with their normal highway programs provided they absorbed their quotas from the relief rolls. The $1,400 man-year factor now applies only in determining quotas to be taken from relief rolls. There is no limitation as to project costs. Regular Federal-aid and State funds may be used to supplement allotments of funds received under the Emergency Relief Act.

At present, the A. R. B. A. is working closely with officials of the Emergency Relief Administration and its allied unit, the Works Progress Administration, in drafting a farm-to-market road program, funds for which would be independent of allotments already made for highway purposes. The Road Builders are seeking to have the proposed farm-to-market road program set up so that it will accomplish maximum results, and so that established procedure may be followed to the fullest extent possible. The Association believes this method will advance the long-range, normal development of the American highway system.

This, in general outline, brings the highway situation up to date. No effort is made here to cover in detail the many problems that have developed, or to outline activities of the A. R. B. A. in its constant efforts to make the public "road minded" in behalf of a normal, adequate highway program and system.

The A. R. B. A. is constantly directing attention to the break-down in highway construction operations caused by diversion of funds that properly should be spent for road building and maintenance. No program can succeed if its life-blood is drained by policies that propagate germs of defeat from the inside. That is what diversion of gasoline taxes and motor vehicle license revenues does.

Also, the Association is driving steadily toward the goal of having highway construction recognized by the Legislative and Executive branches of the Government as a regular, continuing function of Government, to be provided for systematically like other major activities, and on a scale in keeping with modern needs.

Friends of good roads are intensely interested in keeping the subject of adequate highways in step with current, swiftly-moving developments. To do this, they must determine what program will be presented for action by the next Congress and by State Legislatures. The short of it is, they must determine what methods are to be employed in bringing 30-mile-an-hour roads up to modern travel demands.

The highway program has been pulled out of the fire for the present. The problem is to keep it out, and to keep it moving toward the goal of *Adequate Highways for Modern America.*

NEW EQUIPMENT AND MATERIALS

New Heavy Duty Trailer

A 20 ton semi-trailer designed particularly for transporting heavy equipment, such as compressors, tractors and tractor equipment, or general construction tools, has been announced by R. G. LeTourneau, Incorporated, Peoria, Ill., and Stockton, Calif.

This trailer is mounted on sixteen 8¼ by 20 pneumatic tires. Double oscillating walking beams keep the bed level and force each tire to carry its portion of the load regardless of road inequalities. As a result, it is stated, extremely rough ground, such as is so often encountered on construction jobs, may be covered without danger of upsetting the load.

LeTourneau 20 Ton Semi-Trailer

Big tires and heavy duty Timken bearings make for a very light draft. It is stated that on good roads and moderate grades a 1½ ton truck will easily handle the LeTourneau semi-trailer loaded with a 75 h.p. tractor, weighing approximately 33,000 lb.

This unit is built to handle like a 2-wheel trailer, consequently, is easily maneuvered and spotted. It has a very short turning radius and can get in and out of narrow quarters very easily. A long hook up enables the truck driver to back rapidly, yet have the trailer under perfect control.

The weight of the LeTourneau semi-trailer is 7,920 lb. The bed is 100 by 144 in. Length over all is 212 in.

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Briland Multiple Blade Road Maintainer

J. M. Landenberger, Inc., of Ft. Wayne, Ind., has just brought out a new multiple blade road maintainer, known as the No. 35 Briland. This is a "pull" or "drawn" type unit designed to maintain a predetermined crown by means of an independent adjustment of the dragging member on each side. The arrangement in this model permits the use of chains as connections between the dragging member and carrying frame, so that the dragging member will just float over the road surface without being affected by the upward and downward movement of the wheels. Thus, because of such a flexible connection the wheels, either front or rear, may drop into a depression or soft spot in the road and the blades will maintains their same even keel and relationship to road surface which the operator has adjusted for. This is especially desirable in the springtime or during extended wet spells.

The Model 35 Briland has seven blades, and in its design the main carrying frame principal has been retained, with its accruing advantages, the chief of which is to set the blades to conform, from one extreme end of dragging member to the other, to a predetermined crown in the road surface; this adjustment is quickly and easily made by the operator without leaving his position.

Another feature permits the choice of either flexible or rigid connections between the carrying frame and the dragging member. Since major cutting, if any, is performed by the front six blades a rigid connection there is very helpful in that work; on the other hand, since the rear blade does the finishing a flexible connection at that point allows the blade to float, thus eliminating the probability of corrugations in a road surface due to the up and down movements of the rear wheels when rigid connections are used there.

The carrying frame arrangement permits the placing of the rear wheels inside the blade carrying frame, so the outer ends of the blades can bring in material forced to the sides by traffic, and without having the rear wheel churn up the soft shoulders next to the road.

The four wheels are all 32-in. in diameter, are equipped with Timken bearings throughout, and with either pneumatic or solid rubber tires.

The raising shaft, and hand wheel, can be extended from the gear box on maintainer frame to the forward end of the draw bar, and properly supported there, and where the hand wheel is within easy reach of the tractor operator; or it may be extended to the rear end if, for any reason, it is desired to place an operator there. The one shaft is used for adjusting either side of, or raising dragging member entire.

When equipped with power raising device the transmission case is placed on the platform of the tractor, connected to the power take-off of tractor, and with shafts extending rearwards to the gear box on the maintainer frame. From the transmission case to a location convenient to the tractor operator are two levers, operated either singly or together, with which to make the desired adjustments of dragging member.

Regularly the Model 35 is equipped with manually operated remote control hydraulic lifts. The pumps are located on the tractor platform with handles convenient to the driver-operator. The location of these pumps can be changed to a bracket on rear end of the carrying frame, if it is preferred to have the operator located at this point, as in retread work, for example; the double acting rams are attached to the heavy raising shafts.

All seven blades are bolted to the dragging member frame, so they all operate in unison. In retread work, especially, this is very noticeable.

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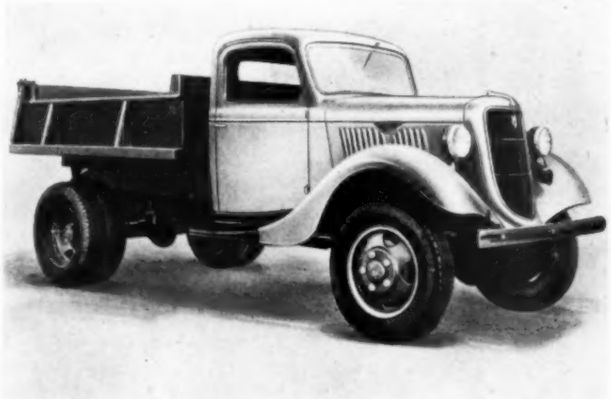
All-Wheel-Drive Ford V-8 Truck With Special Driving Units Engineered and Built-in by Marmon-Herrington

The application of its all-wheel-drive principle of design and construction to the Ford V-8 truck, has been announced by Marmon-Herrington Co. of Indianapolis. An especially-designed driving front axle and propeller shaft, a two-speed auxiliary transmission and other necessary parts, are installed, the remainder of the Ford V-8 truck being retained intact just as it comes from the factory.

All installation and conversion operations are carried forward in the Marmon-Herrington factory at Indianapolis. The all-wheel-drive units are engineered and built-into each truck by Marmon-Herrington and are in no sense to be classed as acces-



Model B5-4 Four-Wheel-Drive with Dump Body

series. Engineering and experimental work has been under way for months and the new "all-wheel-drive Ford V-8's" are tried and proved vehicles in every respect. Numerous models have been on the road in actual service, have been tested on the Indianapolis Motor Speedway and have established remarkable performance records both on and off the highway.

Production has been started on four models, two of which are four-wheel-drive units. These are the B5-4 with wheelbase of 132-in., and the B6-4 with wheelbase of 157½-in. In addition there are two six-wheel-drive units. The four-wheel-drives have a maximum gross capacity of 13,200 pounds and the six-wheel-drives a maximum gross capacity of 22,000 pounds.

The front axles of the new models are full floating, single reduction, with Marmon-Herrington No. 1 constant velocity universal joint steering ends. The two-speed auxiliary transmission gives a total of 10 speeds forward and 2 reverse, and makes possible a total gear reduction of 85.24 to 1. Both the four-wheel drive units are available in three tire sizes—6.00 x 20, 7.00 x 20 and 32 x 6.

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New Material Transportation Cart

A new material transportation cart equipped with full control handles, pneumatic tires and Timken roller bearings has been placed on the market by the Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa. The cart has a liquid volume of 11 cu. ft.; is designed to handle a 1,900 lb. load; the body is of steel sheets with electric welded joints; it is equipped with all steel wheels, Timken roller bearings, pneumatic tires, 4-ply 5 in. by 15 in., and full control handles; the tread measures 36 in.; stands 30 in. high; approximate weight 260 lb.

The design of the body permits the scooping of bulk cement with the cart by running the scooping lip into the material, then bringing the body into an upright position. The new full control handles give the operator full control while dumping the load.

The "Ayrgo" Material Cart

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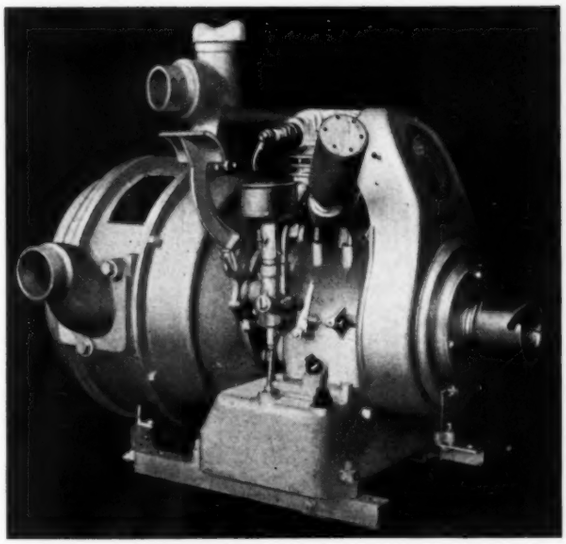
New Marlow Centrifugal Pump

A. S. Marlow, Ridgewood, New Jersey, announces the new self-priming centrifugal pump illustrated herewith. This unit, made principally of aluminum alloy castings, is designed for use where a light-weight, high-capacity pump is required, and is adapted to the needs of utility companies, for cleaning out conduits or manholes; fire companies, for pumping out flooded cellars; water departments, for pumping out ditches; contractors, for pumping out excavations, pier holes, or feeding concrete mixers, filling tank wagons; oil and marine companies, for pumping out barges, etc.



Marlow 2 Inch Self-Priming Centrifugal Pump

The pump has bronze impeller, of open type; cast iron wearing plates on both sides of impeller, which plates can be adjusted for wear or replaced when badly worn; and wear-proof packing, requiring no lubrication. The recirculation control device is entirely automatic, permitting water to bypass as soon as air gets into the section line, and effectively shutting off all recirculation as soon as pump is primed.

The pump is supplied with either four cycle gasoline engine or electric motor drive.

Detailed Specifications

A. G. C. rating, through 2 in. new pipe—166 U. S. G. P. M.
Maximum Suction Lift—25 ft.
Engine—1 H.P., 1 cylinder, 2⅜ in. bore, 2½ in. stroke. Recommended speed—2,200 R.P.M.
Maximum Total Head—35 ft. delivering 40 G.P.M. through smooth bore hose.
Capacity Rating through smooth bore hose and strainer—
120 G.P.M. at 10 ft.
80 G.P.M. at 15 ft.
Over-all Dimensions—25 in. long, 18 in. wide, 19 in. high.
Net Weight of unit with gasoline engine as illustrated—98 lb.
Export packing: gross weight 180 lb. 7½ cu. ft.

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New Churn-Type Drill

Just announced by Bucyrus-Erie Co., South Milwaukee, Wis., is the new Bucyrus-Armstrong 21-W churn-type drill. For holes to 300 ft. in depth and to 6 in. in diameter, this drill makes available the speedy and effective drilling action of its companion machines, the Bucyrus-Armstrong 26 Blast Hole and the 26-P Prospecting drills—but at a materially lower price.

The 21-W is a sturdy, modern drill, of welded, all-steel construction, capable of handling 1000 lb. of tools. It is equipped with the exclusive Bucyrus-Armstrong rubber shock absorber—which makes practical the effective use of wire line. Ample power is furnished by a heavy duty, 4-cylinder industrial gasoline engine. A one-man drill, the 21-W is simple in construction, easy to set up, and easy to operate. It requires little adjustment and very little maintenance.

The 21-W may be mounted on a drill boat by simply removing the wheel mounting, and then setting the machine on two skids.

Choice of mounting is available: on a truck, as a two-wheel or four-wheel trailer, or for team or tractor haul.

HP-100—100-Lb. High Pressure Barrel Pump

One of the most favorably received and widely used items in the recently announced line of 1935 advanced lubrication equipment of the Alemite Corporation, 1874 Diversey Parkway, Chicago, Ill., is HP-100. This high pressure, air-operated barrel pump converts any original 100-lb. lubricant container into an efficient powergun for industrial and truck lubrication. Utilizing a nitralloy piston, a low pressure pump carries a continuous flow of lubricant from the container to a high pressure pump. From there the lubricant is delivered at the rate of 18 ounces of regular lubricant per minute, or 6½ ounces of the extremely fibrous and heavy lubricants. A pressure, 33 times the air pressure used, is available to furnish a delivery sufficient to take care of several outlets at one time.

Alemite High Pressure Barrel Pump

The direct flow of lubricant from container to pump without exposure not only prevents any contamination of the grease, but insures strict cleanliness for the most particular plant. It is stated that using the Alemite barrel pump an entire plant lubrication job can be completed quickly without a single drop of lubricant dripping onto the floor or machinery.

Removal of the barrel pump's top cover, held in place with one bolt, gives access to all the working parts of the double action air motor. The check valve may be cleaned without detaching the hose from the gun.

This maroon, chrome plated barrel pump is provided with either a 3 or 4-wheeled truck for portability or a base for stationary installation.

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Curb Forming Machine

A curb building machine operating on Route 20 at Ashtabula, O., by the Koski Construction Co., is shown in the illustration. The Flex-Plane screeding machine used by the contractors had formed ends, which lifted the exact amount of concrete necessary for the curb. At the time of screeding there was some slump; therefore, shortly behind the finishing machine the material was roughly hoed against the forms, about 1 in. or 2 in. higher than the actual finished curb. The rest of the work was done by the curb building machine.

Curb Forming Machine on Ohio Road Job

When passing over the first time, the forming device had a back and forward longitudinal motion, similar to the transverse motion on the finishing machine screed; this left the material in a semi-finished state. On the next pass, the longitudinal stroke of the forming device was omitted and the device acted as a trowel while the machine moved forwardly, leaving the finish.

The forming device was so arranged that it could be raised or lowered and any amount of pressure exerted against the material to compress it, depending on the weight of the machine. The contractor estimates the machine has done the work of four to five men and it is further stated the work is better and more uniform and there is far greater compaction of the material. The concrete used had a slump of approximately ½ in.

The equipment was furnished by the Flexible Road Joint Machine Co., Warren, O.

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Report of Tests Made to Determine the Suitability of Special Limestone Dust of the Calcium Carbonate Corporation in the Production of Hot Alphaltic Mixtures

The following is condensed from a report by Roy M. Green, manager, Western Laboratories, Lincoln, Neb., July 8, 1935.

Purpose of Filler in an Asphaltic Pavement Mixture. The fine filler, or mineral dust, is introduced into an asphalt mixture for three reasons. First, to increase the density, or decrease the voids. Second, to render the mixture more nearly water-proof after compression. Third, to increase the stability of the composition.

All three of these objectives are reached if the filler has the ability to effectively reduce the voids in the aggregate mixture, provided the filler itself is not subject to alteration from the action of water or the asphalt film weakened under the influence of moisture.

Tests Made Upon Special Dust. The tests made to determine the suitability of this filler were as follows: specific gravity, weight per cubic foot, ability to reduce voids in a sand aggregate mixture, as compared with Regular Quincy limestone dust of the same fineness, and stability and compressibility of asphalt mixtures made of the same two dusts.

Specific Gravity and Compaction: The tests showed that the Regular and the Special Quincy dusts were of the same specific gravity, but that the Special dust offered less resistance to compaction than did the Regular dust.

Ability to Reduce Voids in Mixtures. Curves were plotted to show the ability of the two fillers to fill the voids in the sand mixture, the same sand grading being used with each dust.

The ability of the Special dust in reducing the voids in an aggregate are reflected by the following facts taken from the plotted curves.

	—Regular Quincy Dust—		—Special Quincy Dust—	
Percentage of Filler in Total Aggregate	Per Cent Voids in Mixture	Per Cent Asphalt to Fill Voids by Weight	Per Cent Voids in Mixture	Per Cent Asphalt to Fill Voids by Weight
15.0	21.2	9.6	20.6	9.2
20.0	19.7	8.7	18.5	8.1
25.0	19.0	8.4	17.3	7.6
30.0	18.8	8.3	16.8	7.3

This data shows that if it is desirable to produce a mixture with a low percentage of voids that the Special Dust is much more effective than the Regular Dust. If it is desirable to produce a voidage only as low as is possible with the regular dust this can be accomplished with a proportion of 20% of Special dust as against 30% of the Regular Dust, or a saving of 33.3% in quantity used.

Conclusions. The Special Quincy Dust is a much more desirable asphalt filler for sheet asphalt work than the Regular Quincy Dust, for the following reasons:

First: if it is desired, more highly stable mixtures may be produced by its use;

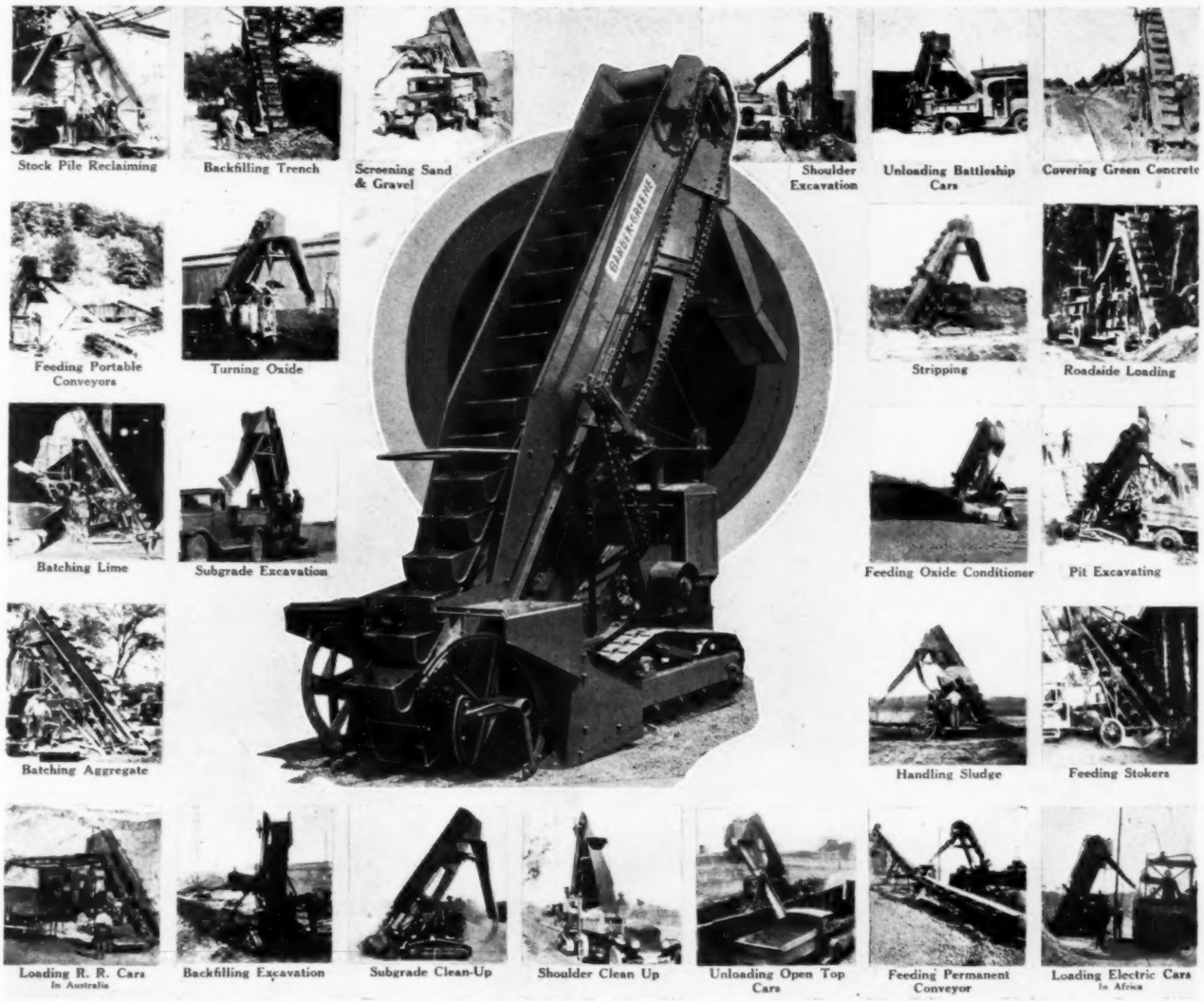
Second: equivalent stability may be obtained with about ⅓ less dust;

Third: mixtures made with it are more compressible than those made of Regular Dust of the same voidage;

Fourth: water does not act as readily upon the bitumen film over the Special Dust.

VERSATILITY

The Barber-Greene Model 82 Bucket Loader is the result of designing loaders for all these applications



NO WONDER our sales have jumped with the announcement of the New B-G 82 Loader. The above photos show a part of the B-G "proving grounds" — stretching from Africa to Australia. These are just 24 of the TWO THOUSAND B-G Bucket Loaders that have been sold.

B-G History includes the announcement of the first Loader with self feeding—first with automotive engine—first with truck type transmission—first and only with the Automatic Overload Release—first and only with the Floating Boom. The 82 makes the biggest step of all—in addition to the above features it has—SYNCHRONIZED FEEDING . . . . SLOW CROWDING . . . . KNEE ACTION . . . . TANK TYPE CHASSIS FRAME . . . . WELDED BUCKETS . . . . HARD FACING ON BUCKET LIPS . . . . QUICK ACTING SELF-LOCKING SWIVEL SPOUT . . . . and many other valuable new developments. Capacity? Two to Three yards per minute (clocked at four). Price? You'll have one as soon as you hear it. Write for complete information. No obligation.

Standardized Material Handling Machines

BARBER GREENE

510 W. Park Ave.
Aurora, Illinois

New Two-Wheel Tractor Derrick

A new 2-wheel derrick for use with tractors is now being manufactured by R. G. LeTourneau, Inc., Peoria, Ill., and Stockton, Calif.

This derrick is very simply constructed, consisting of but three main parts; that is, boom, tongue and wheels. The boom comes in three lengths, 20, 30, and 40 ft.

The LeTourneau two-wheel derrick is operated by means of a LeTourneau 2-drum power unit mounted at the rear of the

Derrick With 40-ft. Boom Breaking Pavement

tractor. One drum of the power unit supplies the hoist line, the other, the boom. The line speed of the lift varies from 65 ft. to 400 ft. per minute, depending on the rigging.

The capacities of LeTourneau two-wheel derricks naturally depend on the size of the tractor to which they are attached. The 20-ft. boom derrick when operated by a "75" will easily lift 12½ tons and carry 10 tons. With a "50" the same derrick will lift 10 tons and will carry 7½. A "35" and a derrick will lift 7½ and carry 5; a "20" lift 5 and carry 3 tons. The LeTourneau two-wheel derrick is stated to be able to lift these great loads because its long tongue places the tractor far enough away from the boom to attain great extra leverage over the load.

The LeTourneau two-wheel derrick can be connected to or disconnected from the tractor by simply dropping the draw bar pin.

▼

The "KOB" Improved Road Material Spreader

A new spreader just introduced by the KOB Manufacturing Co., 329 E. Brown St., Milwaukee, Wisc., is designed low enough for attachment to any of the smaller trucks which is equipped with conventional type body and hoist. It is equally adaptable to large trucks, and may be changed from one truck to another by the simple operation of one long, tapered bolt. Control of material at the tail gate is provided for in addition to control of flow from the spreader hopper through the revolving disc. With this double control the material spread can be moist or dry, coarse or fine, or both coarse and fine mixed, and still spead in a very light application if desired. This ability of applying coarse material in a light application is a pronounced KOB advantage.

The width of spread is controlled by the disc speed and depends directly on the speed of the truck. Spreading speeds will vary between 4 and 11 miles per hour, depending on the results desired. To confine the spread to a very definite portion of the road width, side guards or wings are provided to hook on to either one or both sides of the spreader and thus the side throw of material can be cut off along a given line. These side guards are adjustable to varying widths.

▼

Flash Warning Signal for Repair Work and Temporary Road Obstructions

A new type warning signal designed for use where there are obstructions due to repair work, construction, or any other cause has been brought out by the Universal Safety Apparatus Company, 222 West Adams St., Chicago, Ill.

The device is operated ordinarily by storage battery but is also furnished with connections for commercial current. It is entirely non-mechanical, and requires no maintenance other than the charging of the battery. One charging operates the signal continuously for approximately 134 hours.

The apparatus employs the flashing light principle similar to the "on-and-off" signal used at railroad crossings as an effective warning of approaching danger. This type of warning stands out against street lights, electric signs and other distracting elements.

All vital parts of the signal are hermetically sealed and impregnated with material which prevents climatic conditions from

Universal Safety Apparatus Signal No. 600.

interfering in any way with performance, and assures definite warning regardless of weather.

The signal illustrated is the manufacturer's No. 600. This model has extra outlets for 3 additional standards which may be connected to No. 600 and operated in series on one battery. This arrangement is suggested where a street is to be blocked off due to repair or construction work.

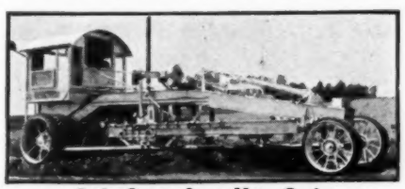
Tests conducted by one of the larger cities have been reported as completely satisfactory.

HOW ELKHART COUNTY CUTS ROAD MAINTENANCE COSTS

• • • • WITH AMAZING NEW TIRES

● What a difference! That's what they said when Elkhart County, Indiana, changed over a tractor from solid tires to Z-P Pneumatics.

Let the man who has been driving that tractor for a year tell the whole story. "Since we have had Goodrich Zero Pressure Tires on this tractor, I can pull through mud, sand or snow without any trouble. I've had this tractor in places that looked impossible to get through, but I always make it. I get more work done because the tractor rides easier, handles better. At the same time fuel consumption is lower." Other users report that they do four days' work in three—that they save a fourth on fuel.



Butler County, Iowa, Motor Grader

CAN'T GO FLAT

You can make similar savings. These amazing tires can't puncture—can't go flat. A giant air cavity underneath the big cleat tread cushions the load, eliminates the bouncing of air pressure tires. The lug type self-cleaning tread has 30% more traction! That's the kind of tire that gets work done in a hurry—that saves real money.

END TIRE TROUBLE

Put an end to tire troubles on graders, mowers, maintainers and tractors. Get the revolutionary Z-P (Zero Pressure) Pneumatics.

See your Goodrich Truck Tire Dealer or write for complete information on change-overs. Address Dept. Z-13, The B. F. Goodrich Company, Akron, Ohio.

Goodrich Z-P ZERO PRESSURE Pneumatic Tires

SPECIFY Z-P PNEUMATICS ON ALL YOUR NEW EQUIPMENT

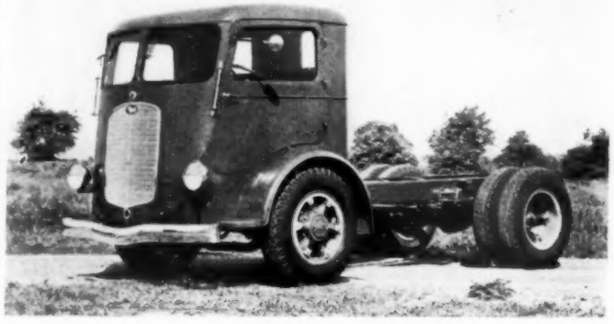
Mack Announces New Styling and Roll-Out Power Plant on Traffic Type Trucks

Modernly-styled streamlined coupe cabs with integral all-metal roof construction feature the new and improved versions of Mack's CH and CJ Traffic Type trucks—the Mack cab-over-engine models. An outstanding feature is the roll-out arrangement which permits the withdrawal of the power plant as a unit through the front, thereby providing greatly increased engine accessibility.

Special attention has been paid to ease of entrance and exit to cab. Doors are unusually wide and are conveniently hinged at the rear. A wide, easy-mounting step is located at the front of the fender at bumper height, and in addition there is a step tread atop the fender. The windshield is divided vertically in two sections, arranged in a shallow V and slanted to prevent reflection. Each section is hinged at the top, thus allowing each one to be opened or closed independently of the other. Driver comfort has been one of the main considerations in the design of the new cabs. The driver's seat is easily adjustable. Careful provision is made for ventilation and rear vision.

A feature of the de luxe cab appointments is an ultra-modern instrument board with clock-type instruments illuminated by indirect lighting. Besides the usual instruments, the board is fitted with a combination gasoline and crankcase-oil-capacity gage. Other cab appointments include automatic windshield wipers, rear-view mirrors, dome light and coat hooks.

A distinct innovation in truck design, the roll-out power plant permits the withdrawal of the engine, clutch, transmission



Mack Model CH Traffic Type Chassis

and radiator as a unit. The roll-out feature comprises a subframe mounting of the power plant whereby it may be rolled out the front of the truck on its own rollers, so that the removal or replacement of the power plant can be accomplished by one man in about an hour and a half. When in position, however, the rollers are idle, the subframe being then rigidly locked to the main frame by 12 large bolts. It is pulled into position by two heavy screw-jacks, one on each side. The withdrawal operation merely requires the removal of the radiator grille and bumper, the lifting of the engine inclosure within the cab, and the disconnecting of the power plant. To simplify the latter, all electrical connections are disconnected with one motion through a multiple connector and socket located under the instrument board.

For routine adjustments and minor repairs, all units are readily accessible. Located between the floorboard and the seats, the engine is covered by a double shell housing of aluminum heavily insulated on the inside, and seating in a felt-filled channel, being thus heat-tight, acoustically dead, and gas-proof. The main housing may be raised and held back against the back of the cab, thus providing access to the spark plugs, distributor, generator, oil filter, and valve tappets.

Wheelbases are 6 in. less than on previous Traffic Type Macks for the same given platform length. This has been made possible by a further setting back of the front axle, the front axle to back-of-cab dimension being now 24 in. as compared with the previous dimension of 30 in.

Mechanical details of these trucks remain unchanged, the CH being powered by the Mack 4 by 5½, 108-horsepower engine; the CJ by the 4¼ by 5½, 118-horsepower engine.

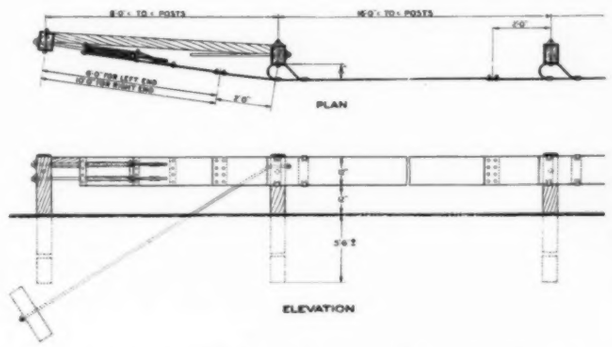
New Highway Guard Rail

"Kalguard", a new highway guard rail, has been developed and placed on the market by the Kalman Steel Corporation, subsidiary of Bethlehem Steel Corporation, Bethlehem, Pa. It consists of strips of semi-spring steel joined together to form a continuous guard rail that is attached to the posts by means of shock absorbing brackets and held in proper alignment through helical-spring assemblies at the end posts.

It is made in standard assemblies, end, bracket, and intermediate sections to facilitate ordering and installation. The intermediate sections of the rail are furnished in standard widths of 12 in. and standard lengths of 16 ft., in any gage specified. However, to meet unusual conditions it may be readily obtained in other sizes. For convenient installation on existing bridges "Kalguard" can be furnished in 18-in. widths.

Standard "Kalguard" and sections, containing the helical springs in a neat housing, come in pairs; one section being 10 ft. in length, the other 6 ft., so that the overlap will always be 2 ft. removed from the post brackets. The "Kalguard" standard post bracket features a combined spring-leaf and semi-circular shock absorbing element made of spring steel. The semi-circular section is located directly in front of the post, while the spring-leaf section extends 12 in. beyond the center of the post. Is is designed to sustain the rail plate against heavy impact without affecting its essential resiliency.

In erecting "Kalguard" no special tool or equipment are required. The brackets are first hung on the posts. One 16-ft. intermediate rail section is then inserted through the four clips on each post bracket. Next, the intermediate plates are loosely bolted together to allow the plate to move freely until the



Plan and Elevation of Installation of Kalguard. Dimensions Indicated Are Those of Most Common Practice

entire rail is assembled. The end sections are then attached to the end posts with 1 in. bolts, 48 in. long, allowing an adjustment of 24 in. which enables the entire length of guard rail to be held in alignment under impact and temperature changes. The nuts of the take-up bolts are housed in a channel which prevents their turning while being tightened.

Where the posts are located close to the pavement and it is not practicable to use the standard "Kalguard" post brackets, special clips are made to hold the rail in place on the posts. The standard post brackets support the rail plate over a length of 16 in. through four separate connections which allow the rail to slide freely in either direction. By this arrangement impact forces are distributed through all the brackets and are dissipated in the end springs.

It is stated "Kalguard" will meet any state's specification for ultimate strength and it will retain its resiliency under compression. It is rolled free from irregularities, and is finished either galvanized or painted, as specified. All bolts, nuts, and washers are galvanized.

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A. W. Dow Now With Colprovia

Mr. A. W. Dow, formerly of Dow and Smith, is now associated with Colprovia Roads, Inc., as vice-president and chief engineer with offices at 801 Second Ave., New York City.

WITH THE MANUFACTURERS

FWD 25 Years Old

The Four Wheel Drive Auto Co., Clintonville, Wis., celebrated its 25th anniversary with the announcement by Mr. Walter A. Olen, president and general manager, of plans for the enlargement of the selling and advertising activities. Mr. Olen stated that total business from all sources for the first 6 months of this year had increased 70 per cent over total business for the same period of last year.

Original Four Wheel Drive Officers Still on the Job at the 25th Anniversary. Walter A. Olen, President and General Manager (seated) with D. J. Rohrer, Treasurer (left), and Frank Gause, Secretary (right), Reminisce Over the Original List of Contributions made by Clintonville, Wis., Business Men in 1910 for the Purchase of the Site for the FWD Truck Plant

FWD manufactures four wheel drive trucks exclusively. The past year has seen the development of several new models, including the Model HS, 1½ ton truck. The company is now making 22 various models of trucks.

Since the inception of business in 1910, Walter A. Olen, D. J. Rohrer and Frank Gause have been, president, treasurer and secretary respectively of the company, without interim.

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New Appointments by Universal Atlas

New appointments in the Universal Atlas Cement Co., a subsidiary of the United States Steel Corporation, are announced by F. L. Stone, vice-president and general sales manager of the company, as follows: R. M. Beaton, district sales manager, New York, in charge of metropolitan New York and northern New Jersey territory. Mr. Beaton has been with the organization nine years serving as salesman for the Atlas Lumnite Cement Co. and later as district sales manager, Albany. Prior to his connection with the company, he was manager, Beaton Brothers Quarry Co, South Ryegate, Vt., and is well known in both the cement and the construction industries. B. J. Whittaker, district sales manager, Albany, in charge of New York state territory. He joined the company in 1929. He was graduated from Wentworth Institute, Boston, where he completed an architectural construction course and later took specialized work in estimating and construction at the Commonwealth of Massachusetts University, Boston. He formerly was field engineer for the Portland Cement Association in charge of structural and concrete products promotion. C. L. Whalley, assistant district sales manager, Newark. Under the supervision of Mr. Beaton he will have charge of northern New Jersey territory. Mr. Whalley has been connected with the organization for 16 years as salesman in New Jersey. He was educated in England. Before entering the cement industry he was assistant manager of the Athey Metal Weatherstrip Co., Chicago.

Bucyrus-Erie Holds Open House at South Milwaukee Plant

Bucyrus-Erie Company's part in celebrating, on July 20, the one hundredth anniversary of the founding of South Milwaukee, was like a chapter from a world's fair. A crowd of 7,000 in holiday mood thronged the plant from one to four, saw the equipment and various steps in the manufacture of excavating machinery, watched machine demonstrations, and came away with candy and cigars as a final token of hospitality.

The sightseeing route was laid out to give a very thorough idea of operations within the 24 acre establishment. Competent guides were on hand to direct and assist as needed: signs and loud speakers at important points gave interesting information on operations and products.

The electric steel furnace was perhaps the most spectacular item, though the casting washer operating at 450 pounds pressure, and the 22 yard bucket through which five people could walk abreast each claimed attention.

View of Electric Steel Melting Furnace—14,000 lb. Capacity. This unit was operated at intervals for the visitors. In the Foreground Are Shown the Materials Used in Making Steel

The company's visitors included many from out of town, as well as the local thousands.

Visitors on Way to Steel Foundry

▼

Kalman Steel Gets R. W. Johnson

R. W. Johnson

R. W. Johnson has been appointed assistant manager of sales of Kalman Steel Corporation, subsidiary of Bethlehem Steel Corporation.

Prior to assuming his new duties Mr. Johnson was secretary of the Concrete Reinforcing Steel Institute, Chicago, and secretary of the Code Authority, Reinforcing Materials Fabrication Industry. He was also secretary of the Steel Joist Institute and of the Steel Joist Institute Code Authority.

Subsequent to his graduation from the United States Military Academy in 1922 Mr. Johnson became assistant city engineer of Indianapolis, Ind. He served later as promotional engineer of the Portland Cement Association, and in 1927 became affiliated with the Concrete Reinforcing Steel Institute, as engineer.

Mr. Johnson will be attached to the general offices of Kalman Steel Corporation, at Bethlehem, Pa. His appointment became effective August 1st.

▼

Albert C. Lehman Dies

After a prolonged illness, Albert Carl Lehman, Chairman of the Board and founder of the original unit of the Blaw-Knox Company, died July 24th at 7:35 a. m. at his residence in Pittsburgh, Pa., the Schenley Apartments, of coronary disease. He was in his 57th year.

Although he has not been active in business, because of ill health for the past nine months, Mr. Lehman was prominent in the steel industry as the head of the Blaw-Knox Company, which he was largely instrumental in building from a small manufacturing unit to a leading independent fabricator of steel specialties. His tireless and aggressive efforts in behalf of the company he organized in 1906 as the Blaw Collapsible Steel Centering Company are a matter of common knowledge in the industry. He served the company first as vice-president, and later as president, continuing in this capacity until recently when he was elected as chairman of the board; this office being created by the board as a mark of appreciation for his efforts in the company's behalf.

He was a director of the Blaw-Knox Company and of the following subsidiary and affiliated companies: Blaw-Knox Construction Co., A. W. French & Co., Hoboken Land Co., Blaw-Knox International Corporation, Lewis Foundry and Machine Co., Pittsburgh Rolls Corp., Union Steel Castings Co., National Alloy Steel Co., Groveton Land Co., Blaw-Knox, Ltd., Milliken Bros., Ltd., Compagnie Francaise Blaw-Knox.

Mr. Lehman was also a director of the Manufacturers' Trust

Be Sure

YOUR BLACK TOP PAVER meets Federal Specifications

Joints made by overlapping cutter bar action. Positive! Accurate! No change in texture at the joint!

Handles trucks like box cars. On actual jobs Adnuns have handled 12 ton trucks on 5% grades with ease.

Government specifications on classes H and I Bituminous pavements call for machine laying!

Before you buy a Black Top Paver, compare the Adnun point by point with other machines. Be sure your paver meets specifications!

The Adnun will operate with headers or curb or other guide line to give positive strike-off control. It lays a perfect joint with header or curb on which the cutter bar reciprocates.

Joints are made by overlapping action. *No blades are used*, and the texture at the joints is the same as the texture in the center of the course.

A "leveling device" is standard equipment on the Adnun. This is mounted on the frame and is free from the excessive vibration present where the level must be attached to wires or connected to and affected by the oscillating action of the screed.

—And the Adnun brings you many other features—exclusive features! The power cut-off, the quick lift, and two speed cutter bar, are just a few of the many money-making advantages that the Adnun has to offer. Write for a catalog.

THE FOOTE COMPANY, INC.
NUNDA, NEW YORK
World's Largest Exclusive Builders of Road Pavers

Roller bumpers contact the truck tires. No power lost to excess friction. No wear on tires.

Smooth as Concrete

FOOTE ENGINEERS

have kept pace with concrete road problems. The MultiFoote Paver is absolutely up to the minute—the latest thing in concrete pavers. When you are in the market ask about its 10 points of superiority.

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